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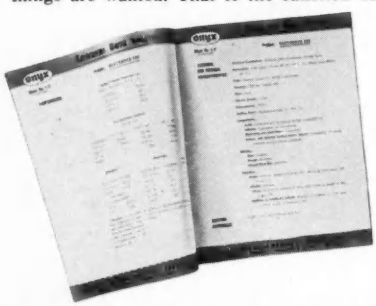

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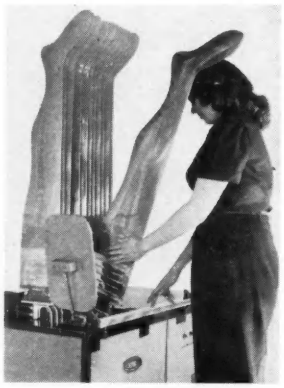

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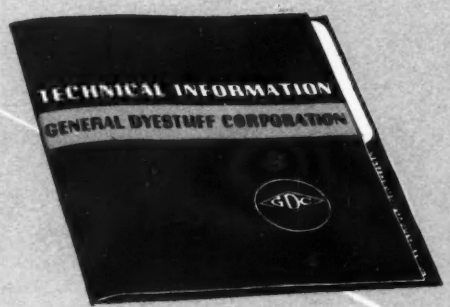

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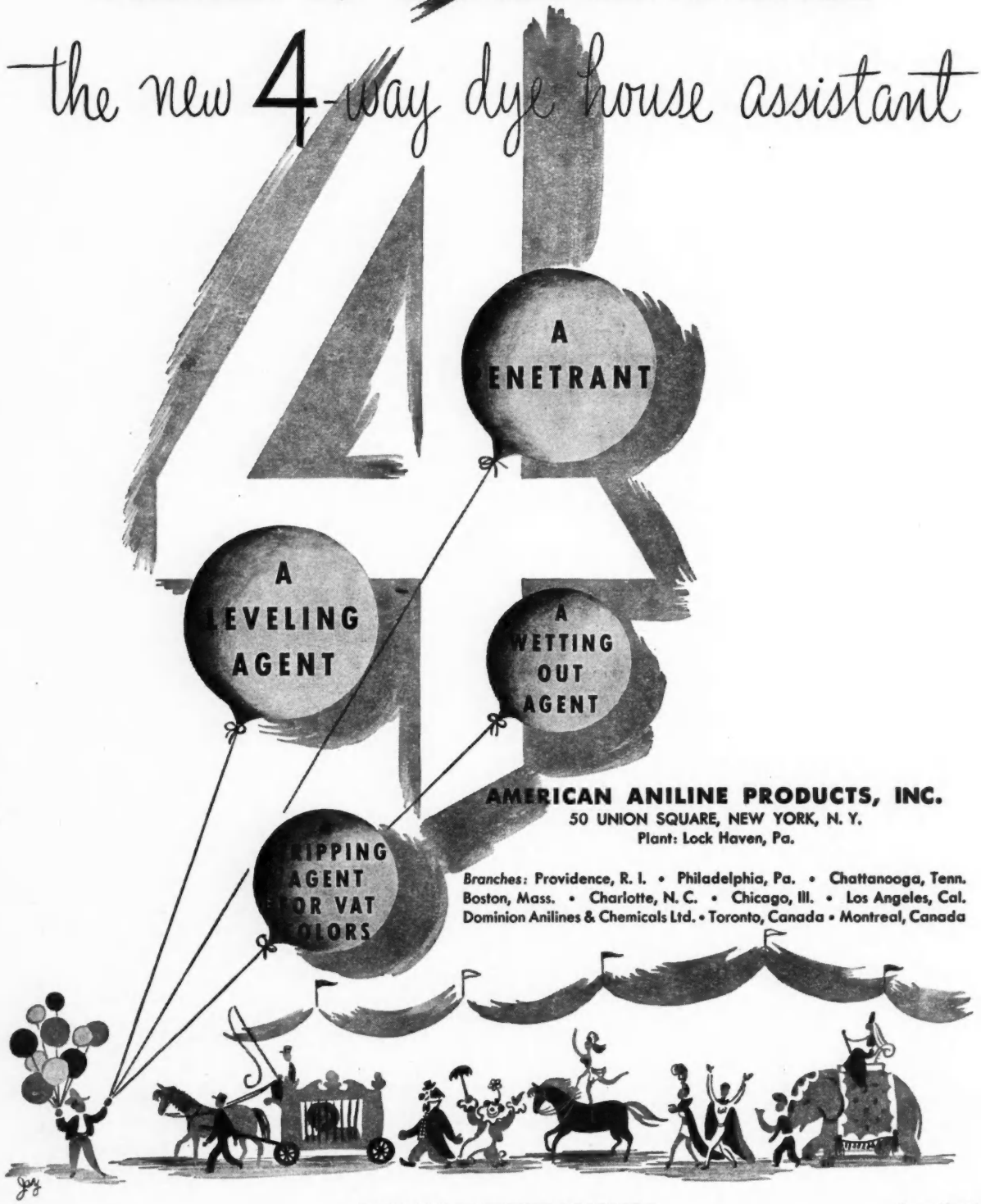

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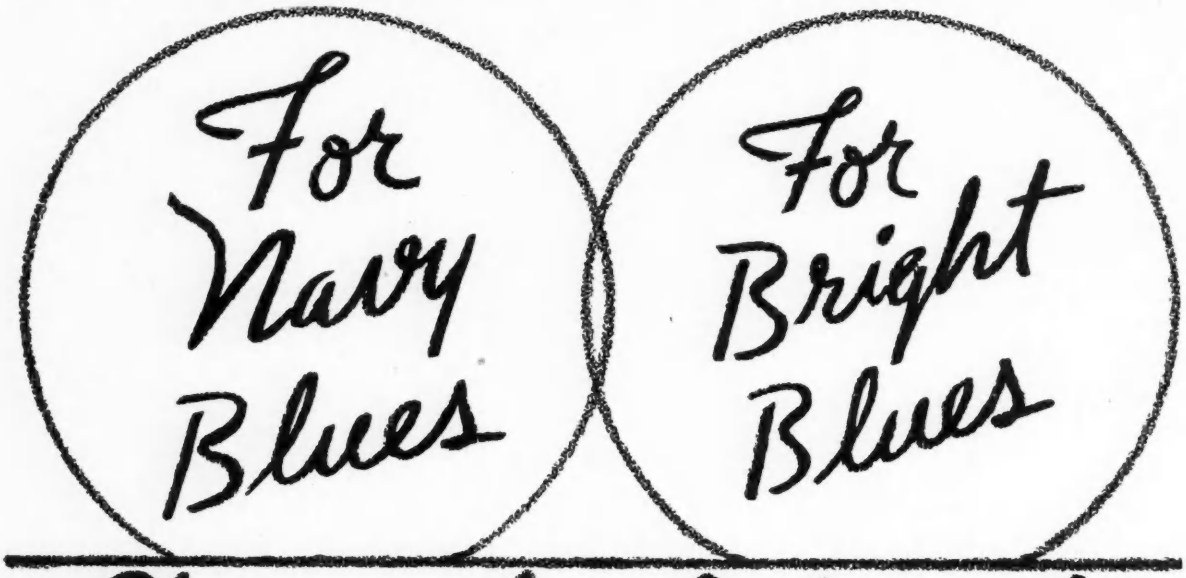

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Contents

Contents of previous issues can be found by consulting the Industrial Arts Index at your library

• Special Articles

Factors Affecting the Development of Mould on Cotton Fabrics and Related Materials..... 343
W. I. Illman and Muriel W. Weatherburn

• Departments

Abstracts from Contemporary Journals..... 365

Patent Digest 366
Paul Wengraf

Trade Notes—New Products..... 368

• Proceedings of the American Association of Textile Chemists and Colorists

Dr. Olney Retires as Chairman of the Research Committee P345

Dr. Chapin Appointed Full Time Secretary.....P345

Communications
Re: Flammability of Textiles.....P345

Re: Possible Formation of a Southern New England Section of AATCC.....P346

Combined Meeting of Northern New England and Lowell Textile Student Sections.....P346

Post-War Textile Processing.....P347
R. W. Jacoby

Textile Resins P352
Walter H. Jaeger

AATCC Featured at PTI Exhibit at Textile Show...P354

Enzymes in Textile Processing.....P355
P. J. Wood

A Method for Recording the Strength of Scouring Solution in Continuous Cloth Scouring.....P362
Ralph E. Hale

Calendar P364

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AMERICAN
DYESTUFF REPORTER

VOLUME 36 JUNE 30, 1947 NUMBER 13

Factors Affecting the Development of Mould on Cotton Fabrics and Related Materials

W. I. ILLMAN and MURIEL W. WEATHERBURN
National Research Council of Canada, Ottawa

Abstract

Study of the influence of temperature and humidity conditions on mould growth on a variety of substances indicated that growth increased in severity and occurred over a wider range of temperature with rise in humidity up to 100%, and that growth demonstrated an optimal temperature range at each humidity. There was no growth at 60% relative humidity and only slight growth at 70% relative humidity (86° F.). Growth on cotton duck both untreated and copper naphthenate treated was accelerated by the presence of free moisture. The removal of constituents of unbleached cotton duck by leaching in water decreased the extent of rotting, whereas leaching with solvent had no effect. The addition of various nutrient solutions to the water-leached fabric did not promote growth to the same extent as did the untreated fabric.

DURING the war one of the most serious problems which arose, particularly in the tropics, was the rapid deterioration of equipment due to the growth of various species of moulds. Much research was directed towards study of the basic facts underlying the development of mould under diffent conditions and methods for the prevention of their growth. Although considerable data had been published regarding the minimum humidity requirements for rapid spore germination and for growth of saprophytic fungi (1, 12, 14, 22, 23), little information was available regarding the optimum humidity and temperature conditions for a variety of species. Heintzeler (15) examined optimum atmospheric humidities for seven named fungi and claimed some repression of growth and sporulation of some of the organisms at extremely high relative humidities. He indicated that moisture tolerance was broadest at the optimum temperature.

It was of interest, therefore, to determine the influence of temperature, humidity and moisture conditions for mould growth and particularly to determine the optimal conditions for mould growth on a wide variety of materials. The information obtained could be of use in preparing a test chamber for determining mould resistance and conversely in determining safe storage conditions for various types of equipment. In this study special emphasis was placed on cotton fabric owing to its wide-spread importance in such equipment as tentage, tarpaulins and webbings. The influence of the removal of water-soluble and solvent-soluble constituents from unbleached cotton on the extent of growth and degradation of cellulose by certain fungi in pure culture at high relative humidity was investigated.

Also the effect of outdoor weathering, which combines the leaching of rain with various other factors, such as the actinic action of sunlight, on the extent of mould growth on unbleached cotton duck, both untreated and treated with copper naphthenate or copper oleate, was determined.

Materials and Methods

(a) Study of the Influence of Temperature and Humidity Conditions on Mould Growth

In determining the effect of temperature and humidity on the growth of a variety of moulds on several materials, latent infection on the articles was supplemented by inoculation with a mixed spore suspension of 15 species of fungi previously isolated from naturally moulded substrates. These fungi were members of the genera *Aspergillus, Penicillium, Paecilomyces, Alternaria, Chaetomium, Stachybotrys, Memnoniella, Rhizopus,* and *Fusarium.*

Small samples of the materials listed in Table I were suspended from wire racks as shown in Fig. 1. The racks were placed in tightly covered glass jars containing solutions of sulfuric acid in concentrations giving relative humidities of 60, 70, 80, 85, 90 and 95% at the respective temperature of incubation. A relative humidity, presumed to be 100%, was obtained by use of distilled water. Various temperatures, namely in °F., 40, 50, 60, 70, 80, 90, 100, 110, 120, 130 and 140 were obtained by use of thermostatically controlled cabinets. The range of relative humidities was studied at the commonly used temperature of 86°F. (30°C.) and the range of temperatures at a relative humidity of 100%. The differential effect of temperature and humidity was

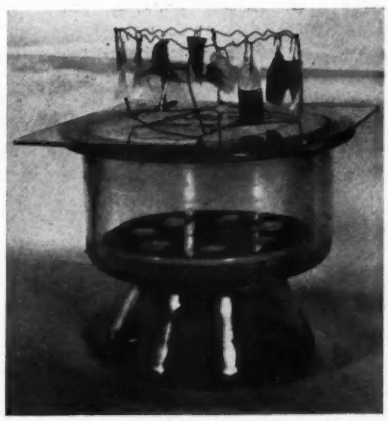

Fig. 1. Materials suspended from wire rack prior to being placed in glass jar.

TABLE I

Amount of mould growth* after 1 month at 86°F. under various humidity conditions

Substrate	Relative humidity (%) 60	70	80	85	90	95	100
Textile materials							
Cotton sheeting, bleached							+++
Cotton sheeting, chrome tint				+	+	++	+++c
Rayon (cellulose acetate)							+
Rayon (viscose)							+++
Wool, scoured							+++c
Packaging materials							
Cellophane, M.S.T.			+	+	++	++	++
Kraft paper, 30 lbs.							+++
Kraft paper tape, gummed					++	+++	+++
No. Ox-ld cloth (wax, scrim, cellophane)		+	+	+++	+++	+++	+++
Electrical insulation materials							
Cotton, dyed			+	+	++	++	+++
Cotton, dyed and lacquered			+	++	++	+	+
Irvolite plastic "spaghetti" tubing			+	++	+++	+++	+++
Rayon (viscose), glass			+	++	+++	+++	+++
Miscellaneous							
Paper, filter (Whatman 4)							+++
Wood, tongue depressor, untreated					+	++	+++
Wood, tongue depressor, waxed (Kendall #5)			+	+	++	++	+++

*Abundant growth +++
Moderate " ++
Slight " +
Chaetomium sp. present c.

studied by use of relative humidities of 70, 80, 90, 95 and 100%, at the previously mentioned range of temperatures and also at 86°F.

(b) *"Tropical Chamber" Tests on Treated and Untreated Cotton Duck*

Large scale tests at 98±2% relative humidity and 97±3°F. were made in a "tropical chamber." This room, (12'x10'x8') with double doors forming an air-lock, was of double-walled wooden construction built on a waterproof concrete base. The humidity and temperature conditions were maintained by thermostatically controlled heaters immersed in a water layer under a discontinuous false wooden floor. Observations were made of the growth of air-borne microorganisms on unbleached cotton duck, both untreated and also treated with copper naphthenate and with copper oleate alone and with the addition of a wax-pigment filler type of water-proofing compound. The unwaxed treatments were applied in the laboratory from solution in Stoddard solvent as described in a previous publication *(3)*. The waxed treatments were commercially applied, all concentrations being such as to give concentrations in the order of 0.1, 0.3, and 1.0% metallic copper on the weight of the fabric. One set of samples was subjected to outdoor weathering* 3 months on the roof of the National Research Laboratories, Ottawa, prior to being exposed in the "tropical chamber."

(c) *Study of the Influence of Free Moisture on Mould Growth on Cotton Duck*

In studying the influence of condensation of liquid moisture on the extent of mould growth on cotton fabric, conditions of 100% relative humidity and 86°F. were used. Latent contamination was relied upon to provide the mould fungi. The fabric was unbleached cotton duck (8 oz./sq. yd.), both untreated and treated with copper naphthenate to give 0.1% copper on the weight of the fabric. The samples, in the form of 1" ravelled strips for breaking strength determinations, were tied with nylon thread around the outside of a specially constructed test-tube which was fitted with a 2-holed rubber stopper containing two pieces of 8 mm. glass tubing. The test-tube was seated in a ½-gallon bottle through the center of a cork stopper (Fig. 5). Water to a depth of 2-2½" was placed in the bottles, and to retard loss of moisture the cork was coated with paraffin wax. On alternate days the bottles were removed from a room at 86°F. to ordinary laboratory conditions and tap water was passed through the tubes of two of the bottles until the samples were adequately wetted by condensation (5 minutes).

(d) *Study of the Influence of the Non-Cellulosic Constituents of Unbleached Cotton on Mould Growth*

Unbleached cotton duck was submitted to various leaching procedures and subsequently to treatment with nutrient solutions prior to inoculation in humid air with cultures of microorganisms. The fabric, a single bolt of unbleached No. 8 cotton duck was cut into pieces 6" weftwise by 14½" warpwise (each piece to provide ten specimens for measurement of breaking strength) and the pieces were distributed in random fashion to the leaching procedures. Leaching procedures for the removal of constituents were as follows:

(1) Tap water at 75±2°F. flowing at a rate of 25 l. per hr. for 24 hours;

(2) Carbon tetrachloride, neutral, continuous extraction through six complete changes of solvent during 24 hours;

(3) Solvent extraction followed by water extraction.

The nutrient solutions which were applied to the leached and air-dried fabrics and to the original untreated fabric were:

(a) salts, viz. ammonium nitrate, 0.50 g., magnesium sulfate 0.12 g., and dipotassium hydrogen phosphate 0.70 g., dissolved in 100 ml. distilled water;

(b) dextrose, U.S.P. grade, 10 g. in 100 ml. distilled water;

(c) alfalfa extract, prepared by autoclaving 30 g. alfalfa meal for 15 minutes in 500 ml. distilled water.

Each solution was atomized uniformly over both surfaces of the samples, the volume deposited on each strip being approximately 1.25 ml. All possible combinations of nutrient treatments were used. Each piece of fabric was folded in accordion fashion and placed in a 16 oz. "French Square" bottle on a galvanized wire rack as shown in Fig. 2. Ventilation of the bottle was allowed through a piece of glass fabric covering a central hole of ½" diameter in the metal cap. The sample and bottle were sterilized at 120°C. for 30 minutes, and 50 ml. sterile distilled water was added aseptically to form a layer under the rack. For inoculation with organisms, cultures of *Metarrhizium glutinosum, Memnoniella echinata, Stachybotrys atra* and *Chaetomium globosum* were used, both singly and in combination. For the single cultures, 2 drops, and for the mixed suspension, 4 drops, of the spore suspensions were added to the water from a Pasteur pipette. After the metal cap was securely refitted on the bottle, the inoculum was distributed over the surface of the sample by vigorous shaking. Incubation was at 86±4°F.

In all experiments mould growth was estimated from periodic visual observations and in certain cases from measurement of breaking strength. Samples for breaking strength determinations were conditioned at 65±2% R.H. and 70±5°F. Measurements were made by the 1" ravelled strip method on a Scott motor driven tester with jaws set 3" apart. Breaking strength loss was estimated from comparison with the breaking strength of the original fabric which had been leached in water to compensate for shrinkage.

(Continued on Page 369)

Fig. 2. Manner in which samples were incubated in studying the effect of various leaching procedures.

*Complete weather data as well as the results of other experimental work on these samples are published elsewhere (2).

Proceedings of the

American Association of Textile Chemists and Colorists

JUNE 30, 1947

Dr. Olney Retires as Chairman of the Research Committee

AT its meeting on June 6th, the Council accepted with regret the resignation of Dr. Louis A. Olney as Chairman of the Research Committee. Dr. Olney has been chairman since the time of inception of the committee and, with the exception of two, has attended and presided over the 151 meetings.

The Research Committee was provided for by action of the Council at its meeting at the Engineers' Club in Boston on November 18th, 1921 and the personnel of the original committee was as follows:

Louis A. Olney, *Chairman*
Walter E. Hadley, *Secretary*
Wm. D. Livermore
Wm. H. Cady
James L. Amsden
Elmer C. Bertolet
Arthur E. Hirst
George A. Moran
Wm. K. Robbins
Walter M. Scott
Wm. R. Moorhouse
Robert E. Rose
Ed. F. L. Lotte
W. J. Murray

The first meeting of the Research Committee was held at the Engineers' Club in Boston on December 9th, 1921 and the first sub-committee, to study the fastness to washing of dyed and printed cotton material, was appointed at its second meeting on January 13th, 1922.

Under Dr. Olney's chairmanship the committee has increased to its present size of over 75 and the number of subcommittees, active and reference, has increased to over 35. In scope, the work of the Committee has broadened to the point where standard test methods of many different types and purposes have been devised. These tests have received both national and international recognition.

Dr. Olney's letter of resignation follows:

Mr. Henry F. Herrmann, President
American Association Textile Chemists and Colorists

Dear Mr. Herrmann:

For the past twenty-five years the work of the Research Committee of the AATCC has been passing through the process of organization.

During that time I have had the great pleasure and satisfaction of acting as Chairman of that body and watching it grow from a small group with relatively narrow operations to one of wide scope and of great importance to the Textile Industry.

With the organization of the Executive Committee on Research, the appointment of a full time Director of Research, and with a full time secretary in the offing, I feel that my work has been completed, and that my services are no longer essential.

I am therefore asking that I be relieved of the duties of the office of Chairman, and am hereby tendering my resignation to take effect at the pleasure of the Council but in any event no later than September 1, 1947.

Naturally it is with no little regret that I make this move as my endeavors and time have been so much absorbed in the work of this committee, but in the interests of the Association I think it to be best.

At this time I wish to express my deep appreciation of the wonderful support that has been extended to me at all times by all the officers of the Association, subcommittee members and chairmen in all of my endeavors.

Sincerely yours,
LOUIS A. OLNEY.

April 21, 1947.

Dr. Olney will continue as acting chairman of the Research Committee until a successor is appointed by the Council.

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Dr. Chapin Appointed Full Time Secretary

AT the Council meeting of the Association held Friday, June 6, Dr. Harold C. Chapin was appointed full time secretary of the Association. Dr. Chapin has served as Assistant Professor of Chemistry in the Lowell Textile Institute since 1920. He received his Ph. D. degree from Harvard in 1910. He became part time secretary in December 1933 and has served the Association very efficiently ever since. Many members of our Association will be pleased to hear this announcement as they have had so many satisfactory and pleasant dealings with Dr. Chapin.

Communications

Re: Flammability of Textiles

Editor,
American Dyestuff Reporter,

Dear Sir:

Your issue of March 24 carries an article by Dr. Herman E. Hager discussing methods of testing the flammability of textiles, from which the following is quoted:

"Dr. Ingberg of the National Bureau of Standards presented a horizontal tester as a good instrument to evaluate fabrics' flammability. However, at a demonstration of the machine at one of our meetings in New York an 80 square cotton sheeting, which in our machine is barely scorched, burned rapidly *and a shaggy brushed rayon* would not even flash over the surface and burned very slowly. However, Dr. Ingberg did not withdraw the machine.

"In April 1945, five boys playing around an open brush fire in Washington were burned to death and five others were seriously injured when the *shaggy rayon chaps of their cowboy suits* caught fire. Our legislators wanted a law passed and Congressman Johnson introduced a bill which was based on Dr. Ingberg's machine. By request a delegation took our tester to Washington and at the Bureau of Standards ran a comparative series of tests which again proved our machine thoroughly accurate and satisfactory. Last December, another Congressman, the Honorable Canfield of New Jersey introduced a bill based again on the horizontal tester."

The following gives a description of the textiles referred to in the above article and the results of our flammability tests therewith:

The "shaggy brushed rayon" referred to as tested at the New York meeting, of which we retained samples, is a shortnapped blue brushed rayon of 11.7 oz. per sq. yd. weight, with length of nap of 0.10 to 0.20 inch. As tested by our horizontal method at the meeting and in later tests, before which latter the prescribed conditioning procedure was applied, it has not flashed and the burning rate has averaged 5 in. per min, which is in line with what would be expected for the given weight. As tested in the 45° position according to the AATCC meth-

od, the flash time has ranged from 5 to 7 sec. It is apparently near the line of 6 sec. average flash time, beyond which textiles are not classed as highly hazardous according to this test. We have no record of accidents with rayons having such short nap.

In our tests with short-napped rayons only one out of 12 different samples tested had burning rate of over 60 inches per minute, the limit beyond which a textile is defined as highly flammable according to House Bill H.R. 601. The sample concerned had a nap of 0.40 to 0.50 in. length. The "Shaggy rayon chaps of the cowboy suits" had nap of 1.1 to 1.2 in. length. This fabric, along with other long-napped rayons, has flashed in all our tests in the horizontal position at rates 120 to 180 inches per minute.

The "80 square cotton sheeting" in tests of similar fabric (67 x 77) burned in the horizontal position at rate of 11 inches per min. which accords well with the weight 3.2 oz. per sq. yd.

It is noted that with the flame applied to the edge, ignition is obtained with all untreated cotton or rayon textiles or materials within the same range of flammability and burning proceeds the full length of the strip, with a rate that may range from 1 or 2 to as many as a hundred inches per minute. We have tried the application of igniting flames on the top surface but the results have been erratic and uncertain, even with flames considerably larger than that applied in the AATCC test.

The horizontal test is primarily one for the determination of rate of flame spread, and with proper limits applied, it will indicate fabrics that have been the cause of serious accidents without including those presenting less hazard. The reason for this is probably that for such incidents there must be rapid spread not only vertically, but horizontally and even downward. A flash that can be obtained with a fabric in the vertical or inclined but not in the horizontal position, very often involves only the tips of the fibers and is self-extinguishing, the backing being not ignited. The occurrence of such flashes on clothing without serious consequences are not uncommon.

S. H. INGBERG,
Chief, Fire Resistance Section,
National Bureau of Standards,
Washington, D. C.

NOTE: Samples of textiles tested were enclosed as follows:

1. Short-napped rayon, 0.1 to 0.2 in. Horizontal burning rate, Five—5 in./min.
2. Medium-napped rayon, 0.4 to 0.5 in. Horizontal burning rate
   [Three—300 in./min.
   [Two—6.5 in./min.
3. Long-napped rayon, 0.9 to 1.0 in. Horizontal burning rate. Five—150 in./min.
4. Long-napped rayon, 1.0 to 1.2 in. Horizontal burning rate
   [Two—120 in./min.
   [One—180 in./min.
5. Cotton sheeting, thread count 67 x 77.
   Horizontal burning rate. Five—11 in./min.

—♦ ♦—

Re: Possible Formation of a Southern New England Section of AATCC

Editor,
American Dyestuff Reporter,
Dear Sir:

The enormous size of the New York Section of AATCC makes it difficult to hold meetings for the full membership. In addition, the holding of meetings in New Jersey is an inconvenience for many of the members living in Connecticut. As a consequence, it was felt that time was right to start a new section of AATCC, holding meetings in any one of three cities: Hartford, New Haven or Bridgeport, in which case the interests of the textile people in Southern New England would be served.

Using the 1945 Year Book as a guide, ballots were sent to all members of the New York section living in Connecticut. A duplicate ballot was sent after a reasonable length of time to those not replying to the first ballot. Members were asked whether they would like to have a southern New England section started. The results of the balloting are shown in Table I. Of the thirty-one answers received, twenty-four are in favor of a new section. Of these twenty-four, twenty are senior members of AATCC. The Association's By-laws require the approval of twenty-five senior members before formation of a new section can be considered.

The purpose of this note is to obtain the opinion of Connecticut members not contacted by ballot as to their wishes in favor of or against the formation of the above mentioned new section. Members of the Rhode Island and of the Northern New England section living close to the Connecticut River who would be interested in meetings held in Hartford and New Haven are also requested to indicate their preference. Please address all letters to Dr. J. Edward Lynn, 1937 West Main Street, Stamford, Conn.

J. EDWARD LYNN.

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Combined Meeting of Northern New England and Lowell Textile Student Sections

INAUGURATING a custom that it is hoped may become an annual event, the Northern New England Section played host to the Lowell Textile Institute Student Chapter at a joint meeting held on May 16th in Southwick Hall at the Institute in Lowell, Mass. Approximately 200 attended the meeting and the dinner which preceded it, including about 75 students and members of the instructing staff.

In commenting on the custom the Chairman of the Northern New England Section, George O. Linberg, stated that it was possible in the future that not only one but possibly two joint meetings might be held: one sponsored by the Section and another sponsored by the Student Chapter.

An unusually interesting program had beeen arranged for the occasion. Sidney M. Edelstein, Technical Director of the Dexter Chemical Corporation, presented a paper entitled: "Old Dyers, Old Books and Old Methods—Remarks on the History of Dyeing and Finishing." Mr. Edelstein had on display a number of old books and manuscripts which he has accumulated over a period of years. Included in his collection are books on chemistry and alchemy and all of the books on dyeing and related subjects published in this country from 1798 to 1890. There are over 2000 items in his collection.

Following Mr. Edelstein a colored sound movie "The Story of Deering Milliken Woolen Fabrics" was presented by Deering, Milliken & Co., Inc. This traced the wool through the mill from the raw product to the dyed and finished material, concluding with a showing of garments displayed by models.

TABLE I
Summary of Balloting for Formation of a Southern New England Section of AATCC
No. of Ballots Sent Out = 50

Senior Members	*Associate Members*	*Junior Members*	*Vote Summary*
20	2	2	In favor of New Section
6	0	1	Against New Section
14	2	1	Did Not Reply
2	0	0	Addressee Unknown

25 Senior Members in favor are sufficient to warrant a new section.

Post-War Textile Processing*

R. W. JACOBY
Ciba Company, Inc.

HISTORY presents a sad commentary of wars occurring with alarming frequency. Each war has left a permanent imprint upon the economic and industrial life of the country, and as these wars have increased in scope and intensity, their after-effects have increased proportionately.

The war just recently concluded affected the textile industry in many ways. The major imprints were in three factors—production, quality and distribution of costs.

I want to discuss these individually but there cannot be a clear-cut separation as they all overlap.

Production

Before the war, it used to be customary for groups of people engaged in a certain line of work to get together and discuss their various problems. One favorite stunt was to ask everybody who was going to attend the meeting to bring with them estimated cost figures on certain theoretical sized runs. The size of these runs were much greater than encountered in business and while they seemed very high then, they faded into insignificance when we got into war production. Continuous dyeing units ran the same fabric, the same shade, twenty-four hours a day, six days a week, fifty-two weeks in a year. In fact, one mill man told me that one of his continuous dyeing ranges produced sixty-two yards of goods per minute for every minute of the year. These tremendous runs were not confined to dyeing. The same thing took place in printing. A camouflage pattern was printed on herringbone twill for fatigue uniforms, on lawns for ponchos and on nylon for parachute cloth. The same patterns and color combination ran in the printing machine for months at a time.

During the war, one of the procurement officers said to me, "Today a million yards is only a remnant". While this is not true literally, it is true figuratively for we went from talking about millions of yards into talking about billions of yards. There were different items on which the Government procured over a billion yards a year.

It is easy for us to say a billion yards. but I wonder how many people here have any conception of what that is. When I first heard of it, I could not visualize any such quantity so thought I would put it in terms of miles and to my amazement, it becomes 568,000 miles. This still is impossible to comprehend. In order to get something to compare it with, I checked with the Hayden Planetarium and found that from the earth to the moon is only 239,000 miles. Therefore, a billion yards of cloth would reach from the earth to the moon, back to the earth again and you would still have 90,000 miles of cloth left, or enough to go around the world three times and you still have 15,000 miles of cloth left over.

Now that we have this conception of a billion yards, let us look at the figures of the U. S. Department of Commerce showing the production for the year 1946. This covers cotton and rayon goods which are known as "wide woven goods" to differentiate from the narrow fabrics such as tapes and webbings.

Finished White—3,579,080,000 yards.

Dyed and Finished — 3,049,957,000 yards.

Printed and Finished — 2,039,313,000 yards.

Woolen and Worsted Goods—603,500,000 linear yards. This includes felt and blankets. Of course, these goods are much heavier and generally much wider.

As I said before, actual production figures now exist on runs far in excess of anything previously estimated and the figures just quoted show the tremendous yardage of business available so that I am sure you will agree with me that when the present seller's market disappears, the struggle for this large production will always be a tremendous menace. Those companies which are so integrated that they have access to the grey goods, have the finishing capacity and the selling organization to dispose of the goods, are going to exert every effort to get this size of business and we are already hearing of concessions which will be made on runs of one, two or three hundred thousand yards.

Developments in Equipment and Processes

To produce these tremendous yardages, there have been many developments in equipment and processes. Undoubtedly some of you remember the old bleaching method where every time the goods received any sort of treatment they had to be piled down into a bin. Then the J box came along which we felt was a tremendous improvement as it made chemicking and souring a continuous operation. Now we have the continuous peroxide bleach units run continually and continuously at speeds up to 250 yards per minute.

Continuous dyeing units have long been in operation, but they have been redesigned, stepped up in speed, and are used not only on vat colors but also on Indigols and sulfurs as well as other types.

Along the line of continuous dyeing, there are two recent developments which are proving highly satisfactory. One of these is the Williams Unit with which I am sure you are all familiar, which consists of a wash box with a frame constructed around both the bottom and the top rollers so that the cloth runs through a very narrow channel. These units run not only very satisfactorily as a booster or reducing unit in a continuous vat dyeing range, but also function as a dyeing unit for other types of colors as well as a very efficient open soaper. According to the latest figures, there have been 170 of these units installed—some of which are used for dyeing and some for soaping. Of these, 110 units are in dyeing ranges, and ranges have one, two, three, or four units to a range. There are fifty dyeing ranges in operation.

The pad-steam system consists of hydraulic pads in tandem with a steam box. I have here pictures of such ranges—one put out by the H. W. Butterworth & Sons Company and the other by John Verduin. According to the latest figures, there are 35 pad-steam ranges in operation. A number of companies have their own homemade system. Steam boxes are generally so designed that a water-well is in the bottom and they can be run either as an entire steam chamber, or by

* Presented at Meeting, Northern New England Section, April 11, 1947.

submerging the bottom rollers, they are run as a combination booster box and steam chamber. The two steam boxes of which I have pictures here, both take the cloth out through a liquid seal. This unit provides for 18 seconds time in the steamer at a speed of 120 yards per minute.

On this Butterworth Unit you will notice that the rolls which pull the goods through have a horizontal nip. This idea of a horizontal nip is being used more and more extensively. I have here two pictures of pads on which the rolls are arranged horizontally. This arrangement eliminates some of the difficulties encountered when the rolls are placed vertically.

This pad-steam unit is also used very satisfactorily on direct colors and sulfur colors as well as other types. I have here a navy shade vat dyed on herringbone twill and I think you will agree with me that this has very excellent penetration. Here is a piece of the same fabric dyed with sulfur colors which has very excellent bloom. Here are a whole group of samples showing the wide variation of shades produced by this method. On vat colors the general procedure is to pad the color on in pigment form and then through a second mangle where the hydro is applied—the caustic generally being applied with the pigment color. Vat colors are also applied in the reduced state and then into the steam box to affect fixation.

In this connection I want to draw your attention to the fact that simply padding color on goods does not dye them. This was brought to our attention very forcefully a number of years ago when the urea printing process was first developed. Fast-to-light direct colors printed by the urea process had very excellent light fastness, but when a tan combination, which had excellent light fastness when printed on this way, was simply padded on to the goods and the goods dried immediately, they had very little light fastness. It was found that if we took a piece of these padded goods, padded them through urea and steamed them, that the light fastness was then equal to that of the printed sample. Of course, steaming the dyed shades is rather a hazardous proposition so the difficulty was overcome by padding on the fast-to-light colors at a temperature of 190° F. The goods were run on a pad so that they were batched up immediately after leaving the nip. In this way the heat was retained. By allowing the rolls to stand four to five hours, proper fixation resulted with the expected fastness to light.

I have here two cards containing swatches of goods to which a fast-to-light direct color was applied. One card represents a color which was just padded and dried. The other one represents a piece of the same goods which was not dried after padding but was steamed. They were then exposed to the Fade-Ometer for the same length of time. You will notice that the padded and dried sample has broken badly and the other has not, and also it is no where near up to shade. This is a fast-to-light direct color which should be dyed at a high temperature so you might say, "Well, it is no good for pad dyeing anyway". We repeated the tests with another color which is considered an excellent padding color and I have those results here. This shows the same situation; namely, that the sample padded and dried is not up to shade nor does it have the light fastness that we expect of the color, whereas the sample padded and steamed is the correct shade and has proper light fastness. I also have here similar samples for the tan combination in question. You note the same difference. In other words, when the color is simply padded on and then dried, the goods are colored but not dyed.

Other Aids to Volume Production

Volume production is being accounted for in a number of other ways. Wool kettles are now being installed that have a capacity for 50 pieces. Dye becks are increasing in size and we now have the double-reel machine in which a much greater yardage can be dyed in the dye beck at one time and I think you dyers will all agree that you have much better chance of uniformity of shade if 6,000 yards is dyed in one dye beck than if it is divided up in 1500 yards each in four different dye becks, because, regardless of greatest care taking, there are bound to be slight differences in time, temperature or other factors. Another step to increased production is to run the dye becks in continuous strand rather than individual strands; that is, to thread them up like a rope soaper and when the goods come to the delivery end of the dye beck, they are carried back either through the solution or in a trough to the entering end. This has the advantage that when your goods come out of the dye beck, they are one continuous piece to be extracted, opened and otherwise processed. When the goods are in the dye beck in individual strands, they have to be taken out that way, tied up in some manner for extracting and then opened individually, layed out and sewed. You may argue that it takes a lot longer to thread up a dye beck continuously than in individual strands which is true, but the general procedure is when we start to empty the dye beck, as soon as the first strand at the entering end is empty, we start running in the next lot so that the unloading time of one lot and the loading time of the next lot is simultaneous.

The soluble salts of the esters of the leuco vat dyestuffs, that is, the Algosol or Indigosol colors, lend themselves readily to this volume production work. They are applied mechanically and then can be developed according to the type of fabric on a jig, beck, continuous range, or any other type of equipment. Due to the fact that they are applied mechanically, they can be run at very high speeds and are finding a very valued place in our production schedule. I have here some various applications of this type of color which might be of interest. The first is a spun glass fabric which is dyed just like any piece of cotton or rayon would be dyed; that is, the regular procedure for Indogosol colors. Do not misunderstand me and think that I am indicating that glass fiber can be dyed. The point is that the individual glass filaments are all coated with a fine film of protein. These filaments are all very fine so that even a minute coating means a considerable amount of protein in the yarn mass and it is this protein which is dyed, and various testing bureaus have pronounced these goods as having good light and wash fastness. Another valuable use is in printing where heretofore direct or developed colors were used in the ground shade and vat colors printed on as discharge colors. Under these conditions, the printed vat colors were much faster than the direct or developed grounds. Very beautiful work is done by printing on vat colors together with a white resist and subsequently dyeing the goods with Indigosol colors. I have a sample of such work here and with this pattern the ground shade is just as fast as the printed colors. These colors lend themselves very readily to application on mixed fibers and here is a fabric consisting of one-third wool, one-third acetate and one-third viscose which is dyed very satisfactorily with this type of color.

In printing, volume production has been accomplished with various mechanical improvements including the high-speed printing machine, roller bearings to facilitate high-speed work and electric eye for guiding the goods into the machine. The net result of all which has been to give greatly increased volume of production. A printing machine so equipped has printed 500,000 yards in a 50 hour week.

Drying equipment has been extensively modified and improved to enable all kinds of high-speed drying and units have become very efficient so that tremendous quantities of water can be evaporated in

a very short time. This is a result of entirely new conceptions as to the theory of drying and it has resulted in tremendous increase in poundage of water evaporated per pound of steam consumed.

Quality

The second point to consider is the impact of the war on quality. Undoubtedly many of you knew of many instances before the war where customers purchased merchandise which did not hold up in service and when complaints were made, the customer was advised that nothing better could be produced. During the war, millions of men and women in all branches of the armed forces had issued to them many different items which stood up under much more severe conditions than they would ever encounter in civilian life. As a result of this, there is no longer a gullible public. These millions of people know satisfactory fastness can be obtained and are going to insist upon it. Although we still have a seller's market and some people may feel that they can get away with anything, there is a rapid trend to increased amounts of vat color dyeing and printing. In the dyeing industry many plants which never before handled vat colors are swinging over to them. I think it is safe to saw that in the future vat color dyeing will be the main-stay of the industry. Further evidence of this is in the tremendous amount of money which is now being spent on equipment for this purpose. One continuous vat dyeing range has just been installed at a cost of $175,000 and the pad-steam ranges of which I showed you pictures are being installed at a cost of from $60,000 to $80,000. Such enormous amounts of money are not being expended for single dyeing units unless it is confidently expected that their output will be in demand and that they will earn their way. Further evidence in this respect is the fact that most producers of this equipment are sold out months ahead and those of you who may have such equipment on order know how long you are having to wait for delivery.

In the continuous dyeing ranges of the old conventional type, the ranges containing Williams Units and the pad-steam ranges, there is always the question of intermediate drying; that is, drying after the application of color. This is a controversy on which one could safely take either side of the argument for there are plants operating both ways who can demonstrate that their methods are entirely satisfactory. There are arguments to be advanced for or against either method so that I think that the question of intermediate drying should be left where it now is and that is a matter of individual preference.

Another development in quality which bids fair to have very satisfactory results is the dyeing with vat colors of fabrics which must be handled in the dye beck. Here the color is applied in pigment form and subsequently reduced in the dye beck. Substantial yardages of underwear cloth for the armed forces were run this way during the war and the same methods are now being followed on goods for civilian use. This is definitely in the development stage but, as just mentioned, it has every indication of being a commercially satisfactory process.

Permanency of Finish

Under the question of quality we have not only the fastness of the dyestuffs themselves but also permanency of finish. A large amount of goods is now finished with various resin finishes and as you know these resins have a very appreciable effect upon the light fastness of many colors. Some colors have their light fastness materially reduced, with others there is practically no effect of the resin finish and there is still a third group of dyestuffs whose fastness to light is materially improved with the resin finish. In addition to this, most of the direct and developed colors have their fastness to washing very materially improved with the resin finish so that with the proper selection of colors it is possible to dye goods with direct or developed colors, give them a resin finish and have them extremely satisfactory from a standpoint of both light and washing.

Under the permanent finishes, various effects are obtained. Shrink-proof fabrics, that is, fabrics with a minimum residual shrinkage, are produced by various methods among which are the urea formaldehyde resin finish, melamine formaldehyde resin finish, methylated melamine formaldehyde resin finish, Sanforset finish which is a treatment with glyoxal and oxalic acid, Definized finish which is a treatment with caustic soda and a protein as a protective colloid, other chemical processes such as the Sayl-a-set and the chlorination process for wool developed by Milton Harris Associates. During the war this was extensively and satisfactorily used on socks and is now being developed on piece goods.

Crush-proof finishes are in extensive demand and are largely obtained with the use of various resins.

Combinations of all the above mentioned points on quality are now being effected so that fabrics are on the market which are guaranteed as having satisfactory light fastness, wash fastness, crush resistance and residual shrinkage. I have here a set of samples of the Bradura Finish produced by the Bradford Dyers Association. These have all of these qualities and are the ultimate in high-quality merchandise. Not only are they beautiful in shade but also they have a very excellent hand and those people who feel that shrinkage or crush resistance cannot be obtained except at a sacrifice of hand will be surprised to see that all of these qualities are obtained without detracting from the hand which is desired.

With all the recent agitation of flameproofing of fabrics due to the California law and the fact that there are several bills pending before the Federal Government, it might be of advantage to take a minute or two to discuss this subject. As you probably know, the standard apparatus devised by the AATCC has been accepted by the California Fire Marshall as the equipment for testing to see whether fabrics conform to the California law. There are five methods of treatment now receiving attention. They are:

1. *Ban flame*—developed by Joseph Bancroft & Sons which is a chemical treatment which is supposed to convert the cellulose into a phosphoric acid ester. I have here samples of chenille, pigmented rayon fabric and spun rayon fabric, all of which have received this treatment and as you can see from this demonstration they really are very flame resistant.

2. *Ellicot Process*—which is an additive compound applied to the fabric.

3. Goodrich Company has a product *Perma-Proof 200* which is also an additive process.

4. DuPont is supposedly bringing out a chemical process, details of which are not yet available.

5. Monsanto, it is understood, is bringing out a material which will be an additive finish.

Mixtures

Mixtures of fibers are coming in for more and more attention and although at first these mixtures used to be for purposes of adulteration, it is safe to say that in the future, mixtures will appear on the market which are made from a standpoint of quality, for it is possible by blending various fibers, to combine their good qualities, with the result that a finished superior product results.

The ordinary well-known mixtures will probably continue in appreciable quantities. These are mixtures of wool and rayon, mixtures of acetate and cotton or rayon, Aralac mixtures with rayon, cotton, or wool and nylon-wool and nylon-rayon, both of which bid fair to become very important mixtures. I have here some socks made of mixtures of nylon

and wool and these are proving very satisfactory. In all mixtures containing nylon, we must always bear in mind the point that nylon has a saturation point. The nylon-wool mixtures are being dyed very satisfactorily by using acid and neutral dyeing acid colors with ammonium sulfate. Nylon-rayon mixtures can be very successfully dyed by using mixtures of direct and acid or neutral dyeing acid colors also in the presence of ammonium sulfate.

Photographic Processes

Just recently there has been considerable discussion regarding two photographic processes. These are the Foto-Fab and the Ross-Smith Company processes. In both instances, the cloth is sensitized and the pattern then produced by exposing the sensitized cloth to the action of light under a film. These two processes differ in that in one case the light destroys the color and in the other case the light develops the color. Both of these processes are now being developed commercially.

Pigments

The application of pigments to textiles is not an outgrowth of the war but considerable yardage of goods was being printed with pigments before the war. Since their introduction, the quality of this work has been improved materially and is now quite a substantial item. As a dyestuff man, it is particularly humiliating to have to draw your attention to the fact that plain dyed effects are now being produced with pigments and I have here a series of samples of spun rayon fabrics in various shades produced with pigment colors on a pad, and also to report that they look much too good.

Distribution of Cost

The third factor in textile operation which has been materially affected by the war is the distribution of cost. In figuring cost in the finishing plant, it generally is divided under three headings—Direct Labor, Direct Material, and Burden. We used to feel that the burden which covers fixed charges such as interest, insurance, taxes, depreciation, selling expense, etc. was more or less fixed. It was felt that there was a good control over the labor cost. As time clocks measured this labor, supervisors were supposed to notice and correct cases of loafing and task and bonus systems or other effort measurement programs were supposed to give an accurate control of labor costs. This left the direct material cost the item which seemed to command the most attention. At that time the purchasing agents had a field day and those of you who had frequent contact with them seemed to feel that they had a very limited vocabulary. All they seemed to be able to say was, "How much?" and "Too much." The only thing that mattered was the cost per pound, per gallon or per yard. The fact that a product had merit to make the additional cost per pound or per yard an advantage seemed to matter very little.

The distribution of cost between Direct Labor, Direct Material and Burden varied, depending upon the type of work being done and the location of an industry, but a representative distribution of pre-war days was about one-third the total cost being absorbed by each of these three items. In other words, they were all of equal importance. Since the war, labor costs have increased far beyond the increases in material and burden. In checking recently with plants whose pre-war distribution of these items was, as above mentioned, one-third of each of the three items, the distribution is now 50% direct labor, 25% direct material and 25% burden. It is now apparent that labor cost is of extreme importance. We find a great deal of attention being paid to "machine-hour cost", the producing unit in a dye works being the dyeing machine and a print machine in a print works. You can run your preparatory equipment or your finishing equipment as much as you want but your entire output will hinge upon print machine production or the production of the various dyeing units. Kettle hour, beck hour, hosiery machine hour, yarn dyeing machine hour, print machine hour costs are very vital and in many instances are greater than the cost of the material used. Anything which will save an hour or two of the time required to dye a lot or anything which will result in greater production per print machine hour is of vital interest and it is often times of value to pay additional money to get this increased output.

It may cost considerably more per yard or pound to use one type of dyestuff than another but if the more expensive dyestuff saves time in a dye kettle or dye beck, eliminates the loss in time of neutralizing carbonized goods, or saves time on any productive unit, the additional cost often is more than justified.

The same thing holds true as regards additional processing. For instance, in thickeners for print pastes in the color shop, it used to be customary to just figure this in terms of cents per gallon for thickeners in the print paste at the machine. Now, however, it may be that cheaper thickeners in terms of cents per gallon may mean extra handling in the soap house, an extra malting operation or additional handling in the finishing department to get the desired hand, so that the cents per gallon saved in the color shop may be more than spent in subsequent operations.

The question of reversing rollers in a print machine with the present high cost per print machine hour can more than off-set any saving in color cost per yard of printed goods.

The present cost of back greys increases the cost of every yard of goods printed to such an enormous amount that it is natural that back grey washers should be installed and used wherever possible.

As an example of saving time in a producing unit, it has been found desirable with goods ordinarily dyed in the dye beck to pad the color on first and then run the goods in a dye beck where dyeing is effected, as this can save two to three hours of the time required in the dye beck. All costs are now considered from the effect from over-all production or over-all operation rather than cost on an individual item or an individual process.

Developments in Other Lines

While the effect of the war on the textile industry has been enormous, it fades in insignificance when compared to the developments in other lines.

There are thousands of young aviators who are safely at home today due to the marvels of LORAN (Long Range Navigation), who were successfully guided to their mission and home again through what otherwise would have been impossible flying conditions.

You are all familiar with the wonders of interception and defense accomplished by radar.

The proximity fuse is now considered to have rendered mass bombing obsolete.

Computing mechanisms as illustrated in the Norden Bomb-sight have reached a degree of perfection undreamed of a few years ago.

Amplidyne power control has given a control of power to a degree never before attained.

We come finally to the greatest development of all, the atomic bomb. Most of you had the pleasure of hearing Dr. Compton give his talk at the annual convention in Boston and I do not know what impressed you the most but his story of the early development was certainly extraordinary. You will recall that he mentioned the fact that the small group of scientists believed that atomic energy could be developed as an instrument of war. The President appointed a group of noted engineers to investigate and report on the opinions of these scientists. Their report was to the effect that

it was absolutely impossible and, in fact, the whole idea was utterly fantastic. And then came the most amazing statement of all. That, up to that time the total amount of U-235 produced in the world was too small to be seen with a microscope and yet these men dared to believe and think in terms of pounds of something they had never seen. That is faith, confidence and daring to an unlimited degree. I wonder if any of us can visualize what would happen to our industry if that same faith and courage and daring was applied!

For years the functions of the human spleen baffled the medical profession. A professor of Physiology was conducting a class in a medical college, when he noticed one of his students dozing; he spoke his name sharply, the chap half awoke, and the professor said: "George, explain the functions of the human spleen."

The fellow was not quite awake, so he said: "Professor, will you please repeat the question?"

Whereupon the professor said: "George, what are the functions of the human spleen?"

By that time, the student was more awake and had his wits about him a little bit. He thought a minute and said: "Sir, I did know, but I have forgotten."

The professor turned to the class and said :"Gentlemen, you have just witnessed the greatest tragedy that has ever befallen the medical profession, here is the only man in the world who knew the functions of the human spleen and he has forgotten."

Application of Theories

I would like to say to you if there is any man in the room who knows what dyeing is, please tell us before you forget. I know there are lots of theories about absorption, adsorption, solid solution, chemical combination, electrical bond, etc. You may have one of these theories yourself, but, if so, does it explain the difference between the colored piece of goods and the dyed piece of goods I showed you previously? If it does, does it explain some of the other things which you encounter in your dyeing experiences, and perhaps take for granted? I wonder how much they create and arouse your curiosity and thought, of what might be back of them.

Let us consider some other examples. You all know that many basic colors when applied on cotton and rayon have very poor light fastness whereas when the same colors are applied on acetate, they have very good light fastness.

Many of the vat colors have excellent light fastness when applied on cotton or rayon but when the same colors are applied on nylon, they have very inferior light fastness; in fact, many will hardly stand any Fade-Ometer exposure.

Many of the acid colors and neutral dyeing acid colors have only fair fastness to light when applied on wool or silk but have very good fastness to light when applied to nylon.

Let us further consider the effects of urea formaldehyde finishes. You can dye a piece of spun rayon with some fast-to-light direct colors and they will have very good light fastness. These goods can then be given the urea formaldehyde finish and they will then have very poor light fastness. Another piece of the same goods can be dyed with other direct colors and they will have fair to good light fastness. These goods can then be given the urea formaldehyde finish and it is found that the light fastness has not been affected. A third piece of the same goods can be dyed with still other direct colors and have very poor light fastness. These goods can then be given the urea formaldehyde finish and the light fastness is materially improved. We know those things, but we do not know why. What is back of them all? We need the same faith and courage and daring of the atom bomb applied to our industry and to these every-day things that we encounter and which we take for granted.

We have been discussing the developments to date, but to my mind, they fade into insignificance. The thing that really matters is: What is the future of our industry? That, Gentlemen, is in your hands. Your field for thought and effort is boundless.

Discussion

Mr. O'Neil: I believe you mentioned that labor now constitutes half or 50 per cent of the cost of production. I am not sure that I caught what the original figures were before the war. What were the figures before the war?

Mr. Jacoby: The figures before the war were a three-way split; one-third direct labor, one-third direct material and one-third burden. Of course, that is going to vary from plant to plant, and with the type of work.

Mr. Cohen: You mentioned ammonium sulfate in dyeing wool and acetate, wool and rayon—

Mr. Jacoby: Wool and nylon.

Mr. Cohen: Would you please elaborate a little on that?

Mr. Jacoby: This particular sock, knitted of yarn containing a mixture of wool and nylon, was dyed with a mixture of acid colors and neutral dyeing acid colors, with 10 per cent Glauber's salt, 4 per cent ammonium sulfate and a wetting agent, one hour, at 200° F. That is all there was to it. We generally use 4 to 6 per cent ammonium sulfate.

Regarding flame-proofing, if anybody is interested in the fire resistance of this Ban-flame, here you are (illustrating). That is supposedly no longer cellulose; but a phosphoric (demonstrating with flame) acid ester. By the way, the Ban-flame process is applied to the good after dyeing.

In these other instances, this chenille is dyed with a direct color; this is the treated sample (illustrating), and this is the untreated. You can see that there is a color change with this direct color.

Mr. Brosnan: I wonder if you could give us any idea of the portion of goods used in the apparel trade that would be affected by this legislation? In other words, how many fabrics will really still be banned under the new regulations?

Mr. Jacoby: The Fire Marshall of California has adopted the AATCC instrument as the standard for testing, the time is six seconds, and most of the commercial fabrics, I mean broadcloths, percales and fabrics of that sort, will all meet that requirement. They have suspended enforcement on Classes 3 and 4, which are the sheer and other goods, until they can arrive at some conclusion, but the fabrics such as flannels, chenilles, and brushed rayon fabrics are the more dangerous fabrics. Most of the commercial fabrics that we encounter today will meet the requirements, except flannels, chenilles and brushed rayons.

Mr. Dalton: Regarding the division of costs, is that true in the South as well as in the North?

Mr. Jacoby: In the South, I would say that the percentage of labor cost is under that. But, of course, the differential has very largely caught up with the North. However, I think there is a difference in the South. I checked down there two weeks ago, and roughly speaking, there has been a proportionate increase in the per cent of direct labor. I know that in the South they are very conscious of machine-hour costs.

Mr. O'Neil: How are the physical properties of these Ban-flame and the other treatments to be compared and applied?

Mr. Jacoby: The Ban-flame is a chemical process which does not affect the hand very much. The Ellicot process is an additive process. That is, there is a large amount of material applied in order to overcome combustion and it gives an entirely different hand to the fabrics. Ban-flame makes the fiber somewhat more brittle. Of course, you no longer have cellulose fiber, but the phosphoric acid ester. I saw samples of napped goods, in which they first gave them the Ban-flame

(Concluded on Page P364)

Textile Resins*

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THE object of this paper is to point out some resins that are being currently used to meet specific requirements in the textile industry. Only those resins that are impregnated into the fabric will be considered in this commentary. All reference to resins in this discussion, will mean that form of compound which is used either in a water solution, dispersion or emulsion. Except for coating fabrics, other solvent systems are used only in rare instances because of the danger of the toxic vapors and the need for special installations for the recovery or the disposal of the solvent. The potential fire hazard from solvent usage results in a greater insurance rate and demands special and expensive precautions in handling.

Two Main Classifications

Of the aqueous resins commercially manufactured, there are two main classifications, namely; thermosetting resins and thermoplastic resins.

The thermosetting resin is applied in solution and polymerizes or becomes insoluble in the cloth through the action of heat and a suitable catalyst. This polymerizing, insolubilizing or infusibilizing reaction is commonly termed curing.

Two of the most widely used thermosetting resins are the melamine formaldehyde and urea formaldehyde types applied as monomers and polymerized on the fabric. Catalysts used to expedite curing are usually acid liberating salts or straight acids.

In order to obtain optimum resin formation, a condition which is largely responsible for the durability of the finished product, temperatures of 280° F. or above are required to cure the resin. Temperatures as high as 450° F. and 475° F. have been used in practical millprocessing to cure resins in cotton fabrics. The time of cure varies inversely as the temperature. Conditions of time and temperature have to be established for each mill depending on the efficiency of the curing range and the density of the fabric being processed. In general, thermosetting resins are dried on the cloth in one step, and cured in another, though both operations can be combined in a continuous range on a production scale. Drying and curing can be accomplished at one temperature in one operation. The fabric does not reach the curing temperature until the moisture has been removed, consequently, there is some doubt as to the economic advantage of this method.

Thermosetting resins yield finishes with maximum durability to laundering and dry cleaning. Melamine resin is used to effectively control the felting and shrinkage of wool fabrics. Urea formaldehyde does not appreciably control felting and shrinkage of wool through both melamine CH_2O and urea CH_2O are used to provide stabilization and durable finishes to cottons and synthetics.

In the thermosetting class of resin, there are several melamine CH_2O and urea CH_2O preparations partially polymerized that are applied in a water medium and cured in the same manner as the water soluble monomer. These are used principally to give body and stiffness to a fabric.

Methylated melamine resins are preferred to urea resins because of greater stability in the drum and less odors from the resin solution in the pad box. Both melamine and urea resins show a slight tensile loss on cotton fabrics. In this case when melamine is used with a special accelerator plus the regular acid accelerator the loss is made insignificant. Where chlorine is used in laundering of urea CH_2O treated fabrics, and an antichlor is either omitted or not thoroughly applied, serious tensile losses result. This is due to the chlorine which is absorbed by the resin molecule and later, on drying, is liberated, tendering the fabric. Though chlorine is absorbed to much the same degree by melamine resins and there is a slight yellowing effect, the chlorine is held differently by the melamine resin and does not react to harm the cotton.

If commercial laundries would exercise care to efficiently antichlor, this tensile loss, a detriment to wider use of resins on white cotton, could be minimized or completely eliminated.

Thermoplastic resins are usually applied as a water emulsion of the already polymerized resin. After they are dried on the fabric, they readily respond to heat. However, being already polymerized, they require no curing though there is evidence of better resin retention and durability if some thermoplastics are subjected to temperatures in excess of 280° F. Thermoplastic resins are rigid at room temperature but can be made to flow or spread by the use of heat and pressure. This is done in the hot calendering of cotton fabrics treated with a vinyl chloride or copolymer of styrene and ethyl acrylate to produce a soft, smooth surface with a sheen.

Now let us turn to some of the outstanding results obtained by applying these resins to various fabrics.

Application to Various Fabrics

Our attention is focused on cottons and synthetics such as Nottingham lace curtains and numerous sheer fabrics such as organdies, marquisettes, voiles, ninons, dotted swiss, lawns and nets. These are treated with melamine resins in combination with alkyds and/or thermoplastic types such as vinyls or acrylate styrenes to produce wash resistant crisp resilient finishes. Advantages of these finishes over the previously used finishes are many: shrinkage control, launderability, slippage control, durable crisp hand, stretch control, creaseproofing, ease of sewing, better resistance to soiling and remarkable light fastness if colored pigment is combined in light shades. These melamine resin combinations are applied on conventional mill equipment consisting of a two or three roll padder. The fabric is impregnated and squeezed, framed dry, and cured.

Let us next consider cotton, synthetic, and some wool fabrics such as are used in windbreakers, children's snow suits, some dress fabrics, shower curtains, table covers and upholstery cloths. These are most desirable as durable water repellent-spot proof and soil resistant fabrics. These features can be brought about by treating with another melamine resin compound using the conventional pad-dry-and-cure method. However, unlike the curtain treatment, this process requires a soaping to remove any uncured resin, remaining catalyst and by-products of the reaction. Fabrics treated with this mela-

* Presented at meeting Mid-West Section, April 12, 1947.

mine water repellent, exhibit a 100 spray rating and less than 20% dynamic absorption. This finish is durable and will resist dry cleaning and laundering and, in many cases, the color wash fastness is improved. By the addition of methylated melamine or urea formaldehyde, to this melamine water repellent impregnation solution, shrinkage control and crease resistance, already partially imparted to the fabric by the melamine water repellent resin alone, can be greatly increased. The end product is a durable, water repellent, crease proof and shrinkage controlled fabric by a simple process.

Cotton crinolene fabrics and interlining cloths combining cotton, some wool and, goat or horse hair can be effectively treated with melamine resin and vinyl styrene or alkyd resins sometimes in conjunction with starch. These resin combinations produce a stiff resilient finish which is durable to laundering and dry cleaning and does not become sticky and limp when wet or damp as previously used finishes.

One of the most outstanding advancements owing its success to melamine and urea CH_2O resins is the production of durable glazed chintzes. Here, melamine and urea resins are applied in the usual manner and the fabric is dried to leave about 8% to 10% moisture in the cloth. It is then friction calendered under pressure of about 2000 lbs. per linear inch of roll width with the temperature of the polishing roll being 300° F. or in excess. To insure complete polymerization of the resins, the cloth is then passed through a heat chamber for from 3 to 6 minutes at 300° F. or above. This is usually followed by a soap and soda washing. Chintz that has been properly processed will not only retain its characteristic gloss through repeated launderings and dry cleanings but it will also embrace an added attribute of controlled shrinkage. Shrinkage as a rule is not greater than 2% in any one direction. Recently, by the addition to the resin bath of a new type softener expertly compounding cationic and anionic agents into one stable product, a still glossier finish with even greater durability is obtained.

Pigment Dyeing and Printing

Resin bonded pigment dyeing and printing is fast becoming more popular in the textile industry and offers increasingly greater competition to other dyeing methods. By the use of fine particle size colored pigments incorporated into the resin mix and padded on the fabric, either as a plain water dispersion or water in oil or oil in water emulsion, excellent light fastness can be obtained along with good wash fastness. The resins employed in this work consist of melamine formaldehyde and urea formaldehyde blends with alkyds and thermoplastics such as polyvinyl acetate and acrylate styrene. This resin pigment process is economically attractive because it combines the dyeing and finishing operations into one simple pad-dry-and-cure step. It offers many possibilities on glass fiber, asbestos fiber and other newer fibers not susceptible to common dyestuff application. Fabric for resin pigment processing requires less preparation to produce uniform results than for customary dyeing procedures and often it can be treated in the grey. During the war, large quantities of nylon insect netting were treated for the government in a one bath process combining color; a blend of resins for slip proofing, firmness and shrinkage control; a water repellent and a mildew proofing agent.

Other Uses

One of the first uses for a thermosetting resin in the textile industry was the polymerization of urea formaldehyde on viscose fabric for crease resistance and shrinkage control under the Tootal, Broadhurst and Lee patent. Later melamine resin, sometimes in conjunction with alkyds or a unique softener such as the aforementioned anionic-cationic agent, entered the field as a creaseproofing resin. It was soon discovered that melamine resin, besides creaseproofing viscose, acted as a permanent gas fading inhibitor, where yarn or construction blends of acetate and viscose were combined in a cloth. It subsequently developed that melamine resin proved to be an excellent durable gas fading inhibitor for acetate fabrics in quantities as low as 3% and 4% resin solids in the fabric.

Another use for melamine and urea formaldehyde resin is in the pretreatment of Sanforized fabrics to minimize the yardage loss due to Sanforizing. As a rule, resin alone cannot quite meet the Sanforizing shrinkage control limits but when combined with Sanforizing, a fabric is produced with durability of texture, besides permanent dimensional characteristics.

Numerous special finishes are being effected through the use of alkyds, partially polymerized and polymerized melamine and urea formaldehyde mixes, vinyl chlorides and acetates, styrenes and acrylates in various blends. These are finishes developed for a particular feel or handle and are adjusted to produce varying degrees of crispness, firmness, softness and fullness with added durability over regular finishes.

Various and sundry other applications of resins to fabrics are far too many to include in the scope of this paper.

I have reserved as my last topic the discussion of wool shrinkage control.

Wool Shrinkage Control

There are several resin processes commercially available at the present for the shrinkage and felting control of wool. The most widely known of these is the melamine resin treatment involving the use of a water soluble melamine either tri-methylol melamine CH_2O or methylated tri-methylol melamine CH_2O. Both of these melamine monomers are capable of forming highly insoluble resins on heat curing. The methylated methylol melamine is preferred to the non-methylated type because it is more stable in the drum and less is required to produce shrinkage control. This melamine resin monomer is soluble in cold water in all proportions, is heavier than water, has a pH of from 8.6 to 9.6 and can be stored for 6 months or longer at ordinary temperatures. It is applied to wool by impregnating the wool with the resin solution and a catalyst, and expressing the excess moisture, drying, curing and soaping to remove surface resin. The most satisfactory practical method of applying the resin solution to wool piece goods is through the use of a pad mangle or any uniform squeeze rolls. Satisfactory impregnation is obtained through the use of pad rolls having a heavy set sometimes pneumatically or hydraulically operated to yield pressures up to 4 or 5 T. based on the standard 50" roll.

Another application method is by submerged impregnation which necessitates custom built equipment to supplement the regular padder. Through the expedient of squeeze rolls submerged in the impregnation solution, the fabric is squeezed while under the liquor and emerges to be again squeezed by a pair of rolls outside the liquor to remove excess moisture as in the normal padding procedure. This method seemingly has the advantage of effecting a more thorough absorption of the resin since the fabric as it leaves the submerged squeeze, having been compressed in thickness, expands and absorbs solution about it in the manner of an ordinary sponge.

However, after a long and careful study of many impregnation designs involving nearly a thousand runs, the very simplest impregnation system surprisingly shows indications of being the best and does not use any special or expensive apparatus. Excellent results have been obtained using a low concentration resin bath and conventional light squeeze rolls, resulting in a high resin solution pickup. The diameter and hardness of the rolls require no special consideration as these factors appear to have little influence on the results. High speed padding minimizing selective absorption also appears to be satisfactory.

Knitted Goods

The most successful applications of melamine resins have been to either woven or knitted wool piece goods. Results of applying melamine resin to wool raw stock have not showed too much promise. However, the application of melamine resin to wool knitting yarn and hosiery has excellent possibilities. Principally because of limitations of existing hosiery mll equipment, adaptable to the resin process, advancement in this field has been somewhat retarded. A piece of appaartus requiring some consideration in this connection is a specially constructed centrifuge whereby batches of hosiery or yarn can be impregnated and extracted in a minimum of time and handling. This machine has the same general construction as the popular centrifugal extractors except that the rotating basket is not perforated but contains an outlet in the bottom which is equipped with a valve. The wool to be impregnated is placed in a wire basket which is placed inside the revolving basket of the centrifuge. The valve is then shut and a small amount of melamine resin is added to the most efficient predetermined operating level and the lid is secured. When the motor is started and the solid walled basket revolved at high speeds, a wall of solution and material is formed under great pressure on the sides of the basket. Usually only a few seconds at high speed are required for impregnation, then the valve is opened and the material centrifuged to minimum moisture content in the usual manner. Very little resin solution is needed by this method.

Drying and Curing

The drying and curing of melamine resin treated wool piece goods can be handled in a single operation though most users employ individual drying and curing units. The customary practice in drying melamine resin treated woolen piece goods as with untreated has been to frame dry to the desired finished width. While this has proved satisfactory to obtain good shrinkage and felting control, even better fabric stabilization can be had by drying in a semi-relaxed condition with just enough tension to keep the fabric straight. Melamine resin does reduce the normal relaxation or sponging shrinkage of wool fabrics when dried to width but this shrinkage can be almost eliminated if the fabric is handled in every operation with the absolute minimum of tension.

Drying can be accomplished at temperature of 230° F. or lower, and the time interval, of course, can be regulated in accordance with the capabilities of the unit. Melamine resin should be cured at a temperature of 280° F. to 300° F. for good results. However, it can be cured at 230° F. for 45 minutes or 400° F. for 20 seconds. It is quite obvious that more dense fabrics will require longer times of cure, hence, one cannot apply time and temperature figures literally, to all fabrics. Consideration must also be given the design and efficiency of the curing apparatus and its ventilation facilities for the removal of formaldehyde vapors. The safest procedure is to establish at the start of a run, the optimum conditions of time and temperature for the particular fabric and equipment. This can be easily done by carefully feeding in small half yard pieces of the treated and dried fabric in question and altering the speed.

After curing, the fabric is subjected to a mild soaping usually in a log or dolly washer to eliminate surface and uncured resin and other residual products of the chemical reaction. After soaping, the goods are then frame dried, again exercising care to minimize the tension.

Hosiery

In the treatment of hosiery, it is possible after impregnation and extraction to dry and cure the hosiery in a relaxed state as for example, on a net belt or screen conveyor type dryer, where the material could be fed in at one end and removed from the other, in one continuous flow. Following drying and curing, the hosiery should then be soaped and boarded dry to the desired size. By predetermining the degree of relaxation shrinkage, in regular hosiery constructions, allowances could possibly be included for this shrinkage by knitting to a larger size and underboarding in the final drying operation. This would produce a sock having the minimum of relaxation shrinkage as well as felting control.

Properties of Treated Wool

In closing, I would like to briefly mention some of the properties of melamine resin treated wool.

1. Shrinkage and felting control. Dry cleaning alone does not suffice to remove such stains as perspiration and other water soluble stains, hence laundries resort to wet dry cleaning or actual light laundering. Resin treated wools resist felting and shinking under these conditions as contrasted to untreated wools.
2. Permanence of finish. A finish is imparted to the fabric for the entire life of the fabric and fuzzing-and-pilling are almost eliminated.
3. Melamine resin treated wool, having shrinkage control, weighs approximately 5% more than the same untreated wool.
4. The resin treatment does not change the moisture absorbency characteristics of wool nor effect the porosity.
5. Increased wet and dry abrasion resistance, and in many cases improved crease resistance result from the resin treatment.
6. Resistance to alkali is greater from treated wool.
7. Garments from melamine resin treated wool retain their shape better, especially knit fabrics. This feature is not only beneficial to the ultimate consumer, but to the cutter, who finds improved tailoring and cutting qualities.
8. Occasionally yellowing of white wool has resulted from melamine resin treatment but this can be effectively removed by merely peroxide bleaching.
9. Slight tensile losses from resin treatment can be minimized by not treating with an excess of resin and by by having the best conditions of drying and curing.
10. As for the possibilities of dermititus from melamine resin treated fabrics, a competent dermatologist has stated as a result of patch tests that such fabrics are neither direct skin irritants nor sensitizers.

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AATCC Featured at PTI Exhibit at Textile Show

THE exhibit of the Philadelphia Textile Institute at the International Exposition of Textiles was based upon the subject matter of the Intersectional Contest Paper presented by the Philadelphia Section of AATCC at the Silver Jubilee Convention in Boston last December. The title of this paper was "The Effect of Dyestuffs on the Temperature Rise of Fabrics Exposed to Light" and was awarded second prize in the contest. Distributed in conjunction with the exhibit was an explanatory booklet entitled "How Cool Is Your Color?"

The exhibit consisted of charts, photographs and equipment which demonstrated how the tests were made. It attracted considerable attention from the thousands who attended the show.

The International Exposition of Textiles was held at Grand Central Palace, New York, during the weeeks of June 2nd to 7th and June 10th to 14th.

National Convention
October 23, 24, 25
Congress Hotel—Chicago

Enzymes in Textile Processing*

P. J. WOOD

Technical Director, Royce Chemical Co.

DERIVATION of the word enzyme is from the Greek *en*—in and *zyme*—yeast.

What is an enzyme?

An erroneous idea held by many people that enzymes are living organisms needs correction. Enzymes are *not* living organisms but are the *products* of living organisms either animal or vegetable. An enzyme may be defined as a soluble, colloidal, organic catalyst.

What is a catalyst?

A catalyst accelerates a reaction which would otherwise take place more slowly in its absence.

Another definition of a catalyst describes it as a chemical element or compound which promotes action between other chemicals without entering itself into the reaction.

Regarding the second definition, there seems to be some difference of opinion. Some people have formulated the theory that some small part of the macro-molecules called enzymes *does* enter into the reaction and that the reaction is reversible, as far as the enzyme is concerned, the active portion of the enzyme resuming its place in the molecule and acting again and again on the substrate under consideration. This would seem to indicate that it should be possible, in the case of the enzymes used for desizing, that one could purchase a few pounds of enzyme and continue to use it forever. However, other factors come into play which prevent this happy eventuality. The products of the hydrolysis accomplished inactivate the enzyme when a certain equilibrium is reached.

There are three classes of enzymes commonly used in textile work:

1. Bacterial
2. Plant
3. Animal

Manufacture

The bacterial type is made from various types of bacteria, the most common being *Bacterium subtilis* and *Bacterium mesentericus.*

A sterilized medium of cereal substrate, generally cotton-seed meal, soybean meal or peanut meal, is inoculated with a culture of one of these types of bacteria, the mass being kept at 30°C. After 72 hours or so, maximum enzyme production is attained. The medium is drawn off, cooled and centrifuged. The liquor is concentrated to the required strength in a vacuum evaporator.

The plant type of enzyme is made from either molds or malt. These two are included in the same group as they are both the products of living vegetable organisms.

The source of the mold type is mostly various species of *Aspergilli*, probably the best known being *Aspergillus oryzae*, other types being *Aspergillus niger, Aspergillus flavus, Aspergillus ochraceous,* etc. One of the richest producers of diastase and protease, the enzymes of chief interest to textile processors, being the last named.† However, it must be borne in mind that these two enzymes are not the only ones produced by vegetable growth, as shown by slide No. 1.

Here we note the presence of *Alpha-* and *Beta-amylase,* whose function is the liquefaction of the starch and its conversion into various reducing dextrines and sugars, *maltase* which converts the dextrines into maltose, lactase which produces lactose or milk sugar, under certain conditions. Also *pectinase,* which may be a mixture of several enzymes having the property of converting pectin into reducing sugars. This enzyme may perform a useful function in desizing cotton goods as certain pectic matters are found in raw cotton itself.

Then we see *polypeptidase* and *proteinase,* two enzymes or enzyme systems, acting on proteins to form successively peptides and amino acids.

Finally, we note the presence of *lipase,* a fat-splitting enzyme, which may help to emulsify the fats and oils present in the sizing and naturally occurring in the cotton fiber.

The presence of *cellulase,* which hydrolizes cellulose, does not appear to be beneficial, but it is likely that it may be present in commercial desizing agents in such small proportion that its action is negligible. *There is no record of any damage to the fiber traceable to the use of any desizing agent.*

The Enzyme Systems of Two Important Molds*

Aspergillus Oryzae	
α-Amylase	Rennin
β-Amylase	Lipase
Maltase	Amidase
Lactase	Cellulase
Pentosanase	Cytase
Pectinase	Phytase
Trehalase	Nucleases
Tannase	Sulfatase
Catalase	Pyrophosphatase
Proteinase	Phophodiasterase
Polypeptidase	Phophomonoesterase
Dipeptidase	(acid phosphatase)

Aspergillus Niger	
α-Amylase	Rennin
β-Amylase	Lipase
Maltase	Amidase
Lactase	Cellulase
Trehalase	Glucose oxidase
Tannase	Glucose dehydrogenase
Catalase	"Zymase" (trace)
Proteinase	Urease
Polypeptidase	Inulase
Dipeptidase	Melibiase

* Courtesy of Dr. Henry Tauber, "Enzyme Technology," p. 128.

Slide No. 1

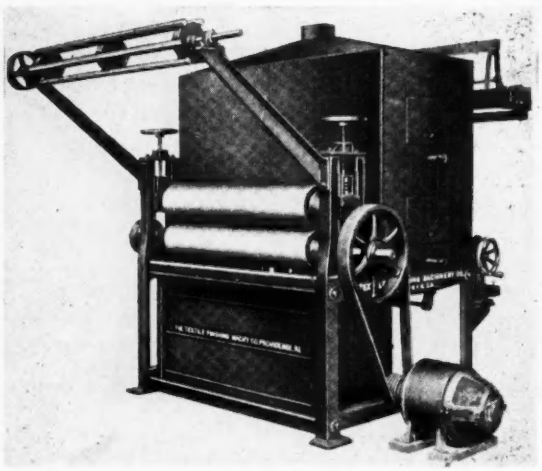
Researches by several competent investigators appear to point to the conclusion that most enzymes, when isolated and prepared in as pure a form as possible, do not work as well as they do when used along with the co-enzymes with which they are associated in nature. This is quite understandable. It seems logical to assume that these co-enzymes may function as catalysts to the catalyst, so to speak, or activators. If they were not necessary, Nature would not provide them, as we know Nature's laws admit of no waste. Evidently, one works the better for the presence of the other.

Mold enzymes are made by cultivating the spores of a particular mold on a medium of wet bran, usually wheat or rice, previously sterilized to eliminate wild molds. Exact conditions of moisture, temperature (30-35°) and pH must be observed. In anywhere from 1-2½ days, growth is complete. The moldy bran is leached with water, filtered and alcohol is added to precipitate the enzyme, which is dried in vacuo at low temperature.

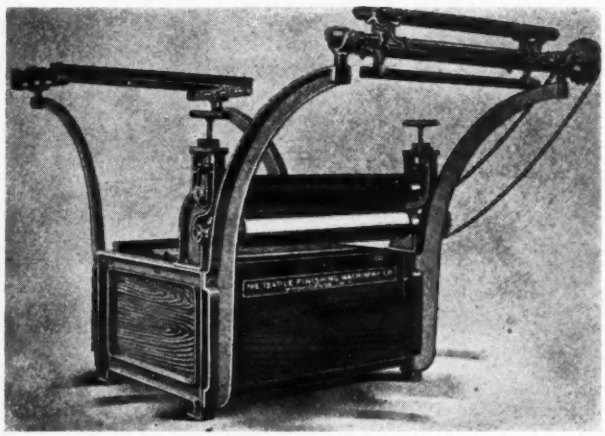
Malt enzymes are made by steeping ground malt in water and filtering. The

* Presented at meetings, Philadelphia Section, January 9, 1947 and Rhode Island Section, April 25, 1947.

† "Enzyme Technology"—Henry Tauber, p. 128.



Slide No. 2 *



Slide No. 3

filtrate is concentrated in a vacuum evaporator to the required enzyme content. Most malt enzymes are used in the liquid form, although it is possible to precipitate the enzyme from the filtrate of the extract with alcohol, after which the precipitate is vacuum dried at low temperature.

Animal enzymes are made from the pancreas of the edible animals, sheep, steer and pig, the two latter being more commonly used. The pancreas of the hog is the richest source. Considering the catholic taste of the pig in the matter of diet and his apparently enormous appetite, this is not surprising.

The glands are minced, dry cleaned with a volatile solvent, to remove the fat, and extracted with water. The filtrate is treated with alcohol and the precipitate dried in vacuo at low temperature.

All these commercial desizing agents are carefully standardized, the diluents used being either inert or helpful in the desizing process which they are designed to perform.

Application

Desizing agents can be used in any of the conventional forms of desizing machines in general use.

The requirements for the successful use of these compounds are:

1. That the goods must be thoroughly wetted out and saturated with the desizing liquor.

2. That the liquor must be kept at the optimum temperature for the particular enzyme being used.

3. That the goods should carry out of the desizing bath their own weight of liquor, 100 per cent impregnation.

* Photographs of machinery through courtesy of H. W. Butterworth Sons Co.

In some bleacheries desizing is carried out in the quenching box following or attached to the singeing machine. This arrangement is illustrated in slide No. 2. In a small quenching box, such as the one in this figure, in which the goods dip only once into the liquor, there is a likelihood that the goods will be insufficiently wetted particularly if the raw material is at all resistant. There is also considerable danger that the heated goods emerging from the singer will heat up the desizing liquor to a point above the optimum temperature for accomplishing the best result. This is more likely to happen when the singeing is being carried out at low speeds, 100-150 yds. a minute than when higher speeds, 350-350 yds. a minute are used. At the high speeds the cloth is not heated up by the flame to the same extent.

The first mentioned difficulty can be overcome by addition of a suitable wetting agent to the bath. All wetting agents are not applicable to desizing materials; some of them impair or inhibit entirely the action of enzymes.

The second danger can be avoided by running in the desizing liquor continuously from the overhead supply tank and providing a small pump to circulate the liquor from the quenching box up to the supply tank. In some other bleacheries, the goods are plaited down in trucks from the singer and run through a much larger box provided with several idler rollers, giving the cloth a series of dips, and a final squeeze. This is shown in slide No. 3.

An even better arrangement is shown in the next slide No. 4. In this machine the goods get two very adequate multiple dips each followed by a squeeze, thus assuring ample impregnation.

Another very satisfactory device for applying the desizing liquor is the three-roll mangle shown in slide No. 5. The goods are passed through the tank on one side of the mangle, passing through the lower nip into the tank at the other side of the mangle, back through the upper nip, around the top roller and thus out of the machine.

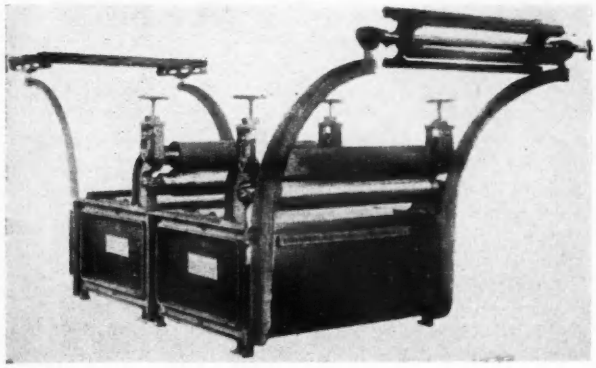
It is good practice to heat up the water first to the optimum temperature as specified for the particular enzyme being used. Then add the necessary quantity of enzyme and wetting agent and any other additions recommended. It is not good practice to add materials with the steam on. Steam destroys all enzymes, even the most heat-resistant.

Similarly, it is better to use an open steam pipe in the desizing box to maintain the temperature at the optimum degree, rather than a closed coil. Likewise, it is inadvisable to attempt to keep the temperature uniform by leaving the steam on continuously, "just a crack." It is far better to introduce a "shot" of steam when necessary, and the pipe soon cools down to the temperature of the liquor. This causes minimum damage.

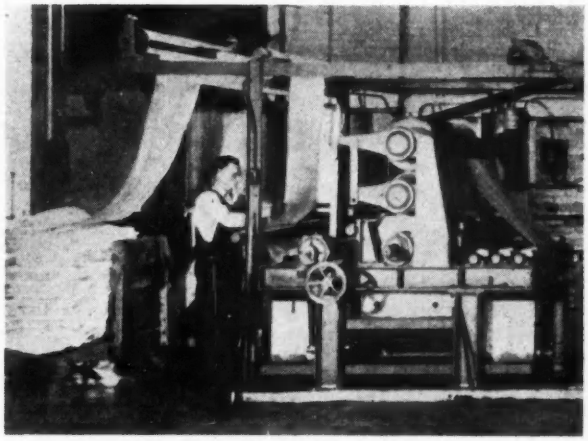
One of the best arrangements we have seen was a desizing box fitted with an automatically controlled valve which kept the liquor within half a degree plus or minus of the optimum temperature.

On emerging from the desizing operation, the goods are either plaited down in closed trucks or into a J-box or bin.

The time of lying over varies according to the routines in different mills and according to the speed of reaction of the enzyme being used. Then again, some goods contain less starch than others and take less time for conversion. This also depends a great deal on the temperature maintained during the lying over period. The nearer the temperature of the treated



Slide No. 4



Slide No. 5

goods can be kept to the temperature of the desizing bath, the quicker the conversion of the starch. For this reason it is desirable to cover the goods to retain the heat.

At the conclusion of the lying-over time, the goods may be taken directly into the kier or open boil-off, or may be washed first.

So far we have considered the desizing of goods in which the warps have been sized with starch of one kind or another. In other words, we have been concerned with the amylolytic action of the various enzymes. Sometimes warps are slashed with proteins, glue and gelatine being most commonly employed, particularly in the case of synthetic fibers. Very occasionally casein is used. These protein sizes are removable by means of the same enzymes using different optima of temperature and pH. At this point, it may be interesting to compare these optima for the various enzymes for both types of activity. This is shown in slides No. 6 and No. 7.

As explained previously, all enzymes are complex in character and contain varying proportions of amylolytic and proteolytic enzymes, as well as a host of other enzymes having very diversified functions, but these may well serve as activators to stimulate the reaction of the principal enzymes with which we are mainly concerned in the desizing process, be this amylolytic or proteolytic. We know, for instance, that in the human digestive system, the presence of amino acids, the products of the combined action of the enzyme pepsin, in the stomach, and trypsin in the duodenum, do stimulate the action of the pancreatic amylase in the conversion of starches to sugars. It is logical to assume, therefore, that the byproducts arising from the reaction of many of these co-enzymes may be beneficial also.

It is quite likely that the presence of these other enzymes may have some bearing on the optimum pH requirement. It has been demonstrated that pure trypsin has an optimum pH of 7.4, while crude pancreatin, a mixture of proteolytic enzymes together with amylolytic enzymes seems to have an optimum pH of 8.3 for proteolytic activity.

OPTIMA of TEMPERATURE and pH for VARIOUS ENZYMES

Amylolytic Activity

Source	*pH*	*Temperature*
Bacteria	6.0-7.0	158°F
Plant		
Mold	5.4-5.6	122°F
Malt	5.0	131 -140°F
*Pancreas	6.8-7.2	122°F

Proteolytic Activity

Source	*pH*	*Temperature*
Bacteria	6.5-7.5	
Plant		
Mold	6.0-7.0	122°F
Malt	4.1	
Pancreas	8.0	122°F

These values only hold for very definite conditions. The buffer used and the temperature both can exert considerable influence on the optimum pH of an enzyme. The length of time and the extent of the hydrolysis will influence the optimum temperature. Increasing the temperature of an enzymic reaction causes the enzyme to act at an accelerated rate, but, at the same time, the destruction of the enzyme is accelerated and, with extended period of hydrolysis, the benefit of increased rate of hydrolysis is more than offset by the increased destruction of the enzyme.

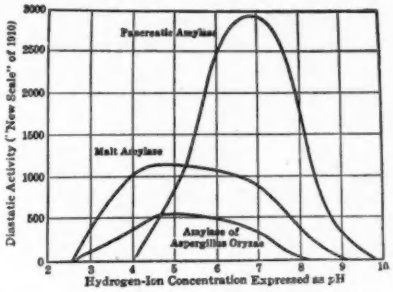
The optimum pH for the proteolytic activity of an enzyme is influenced also by the substrate as well as by the factors already discussed.

* The figures given for the amylolytic activity of the enzyme from pancreas were established in the presence of 0.01 to 0.02 m NaCl.

Slide No. 6

Desizing of Synthetics Slashed With Gelatine

This can be carried out on the some forms of apparatus as indicated for the treatment of cotton for removal of starch. In many places, the goods are padded with the solution of enzyme and rolled up and laid over in this form for the necessary period, which seems to be shorter than that required for amylolytic action. This method is suitable for goods which are intended for dyeing on the jigger, flat goods. In the case of spun synthetics, the desizing can be accomplished by treatment on the dye-reel preceding the scouring operation. Sometimes a short run in the desizing liquor at the correct temperature and pH is sufficient. We have seen synthetics successfully desized in 30-45 minutes by this method. When the desizing is completed, many people add the scouring materials to this liquor, raising it to the scouring temperature, thus saving water, time and precious BTU's. It is quite possible to use this same liquor for the dyebath and make a further saving. The main objection that has been urged against this system is that it occupies dyeing time on the dye-reel. To obviate this loss of dyeing time, it is thought better, in some concerns, to make a separate operation of the desizing. The goods are passed through the enzyme and passed into a short J-box



Courtesy of Dr. Henry Tauber, "Enzyme Technology," p. 129.

Slide No. 7

from which they are plaited down in trucks ready for the dye-tub. Another method, which takes care of both scouring and desizing, consists of passing the goods in the open width through a 5 or 6 compartment open-width washer. The first compartment is furnished with full strength detergent at the optimum temperature for the fiber or fibers being treated, the second with half strength detergent, or less, after which the goods pass through hot water in the third division of the machine then through water at the optimum temperature for the enzyme being employed. The last compartment contains the enzyme liquor at the optimum temperature and pH for the particular enzyme, after which the goods are squeezed with suitable pressure to allow them to carry over 100 per cent liquor content. They are plaited down in trucks, allowed to lie for the necessary time, varying with the enzyme, after which they are ready for dyeing. Automatic level and temperature control, at least in the enzyme compartment, can make this a very economical operation.

To argue the necessity for desizing operations would seem to be superfluous, in these modern times; but, strange to say, there are still a few people who feel that it is unnecessary. They maintain that the kier boil hydrolyzes the starch sufficiently without it.

The substances present in raw cotton cloth, as it comes from the loom, consist of the starch used in slashing, amounting to roughly an average of 10% or more of the weight of the fabric, and from 4-5% of matter normally present in raw cotton. The desizing with enzymes, if properly conducted, should eliminate al- of the starch and, in the case of some of the enzymes, at least some of the other natural impurities of the cotton, thus leaving much less work for the kier boiling to do. Where the enzyme treatment is carried out simultaneously with the singeing operation, in the quench box, it can hardly be said that it involves an extra operation. The material cost is negligible, and it is likely that a careful investigation would reveal a saving in either the boil-off or the bleaching that would more than compensate for this expenditure.

Evaluation of Enzymes

There are numerous methods of determination of enzyme value. Each one of these methods is useful for estimating the value of an enzyme for some particular purpose or end use.

To illustrate some of these let us consider the following four.

1. *The viscometric method.*

This method is based on the measurement of the liquefying action of a known quantity of the enzyme on a measured volume of starch solution of known starch content.

The activity of preparations containing amylase may be determined quantitatively by measuring the changes in the viscosity of starch solutions. A starch solution two and a half times as viscous as water is the most suitable for accurate measurements. With some preparations of soluble starch, a 2% solution is sufficient, while with others, as much as 6% is required. Two to six grams of soluble starch are added to 100 c.c. of distilled water; the mixture boiled one minute, then autoclaved at a pressure of 18 pounds for fifteen minutes and filtered through muslin. Very little hydrolysis occurs as a result of this treatment, but if the starch is heated in very acid or alkaline solutions, caramelization is produced. The reaction of this solution is usually pH 5.6, but if other hydrogen ion concentrations are desired, a double strength starch solution is made and added, after cooling and filtering to an equal amount of the buffer solution made up as follows:

25 c.c. of 0.4M NaCl solution
8 c.c. of 0.4M Na_2HPO_4
4.5 c.c. of 0.4M NaH_2PO_4
Make up to a final volume of
250 c.c. with distilled water

These starch solutions should be used within 24 hours after preparation.

Ten cubic centimeters of this starch solution are placed in each of two large Ostwald viscosimeters immersed in a glass water bath at 34° C. (95° F.) and the time required for 5 c.c. of the solution to flow through the capillary tube is determined several times with a stop watch. This time value will hereinafter be designated as the "viscosity" of the solution. The viscosity of starch solutions prepared in this day is usually stable, but occasionally a preparation may be found which decreases in viscosity. Such solutions are useless for amylase determinations. If the initial viscosity is stable, 0.1 to 0.4 c.c. of the preparation containing amylase is added to one of the viscosimeters and the same amount of the enzyme preparation, after inactivation by boiling, to the other as a control. The contents are then thoroughly mixed by shaking and the time noted. The viscosity of these mixtures is then determined at intervals of three or more minutes for a period of one to two hours.

The results obtained may be plotted on coordinate paper, the abcissae representing the elapsed time between observations and the ordinates the observed viscosities expressed as percentages of the initial viscosity; the initial viscosity which is measured in seconds being recorded as 100%. For example, if the observed initial viscosity of the starch solution before adding the enzyme is one hundred and seventeen seconds, it is represented on the ordinate scale as 100 (abscissae scale 0). If the observed viscosity, 12 minutes after adding the enzyme, is ninety-seven seconds, the ordinate would then be 83 (i.e., 117: 100 equals 97: x and x equals 83) and the abscissae 12. This apparently complicated, though really simple slide-rule method of recording results is necessitated by the fact that since several different viscosimeters are usually used, the initial viscosities are frequently not the same and, therefore, must be reduced to the same scale.

Comment

This method shows the reduction in viscosity of a standard amount of starch by the given amount of enzyme over the period covered by the observations made during the experiment. It would appear to be more useful in the determination of the suitability of an enzyme for the purpose of liquefying starch for the preparation of finishing preparations for textiles or paper than for the process of desizing. Lenk, an English investigator uses a similar method as the basis for estimation of the value of enzymes, seeming to feel that it bears a direct relation to the value of the enzyme for all purposes. However, he has a method of classifying the various starches as to their susceptibility to liquefaction and, in his method, he evolves a factor for the starch used to correlate it with any other starch which may be used.

2. Method of measuring the digestion of starch by enzymes.

This test is based on the amount of enzyme required to fully convert a fixed amount of starch in 30 minutes, under standard conditions.

Starch: Weigh out the equivalent of 20 grams of raw potato starch. Mix in about 100 c.c. of distilled water in a 250 c.c. beaker. Tare pan and paddle on balance. Measure 550 c.c. water in graduated cylinder. Put about 2/3 of this into the tared pan and heat. Remove from the fire and wash in the starch with the remaining 1/3 of the water; return to the fire; raise the temperature to the boiling, stirring constantly, reduce flame and start timer. Boil and stir 10 minutes. Remove pan to cold water tray and cool with stirrings. Wipe bottom of pan and bring contents to 600 gm. Mix well. Weigh out a set of seven tubes of 7.5 gms. for each test.

Sample: A suspension of the desired concentration is prepared by mixing enzymes with a small amount of water and working into a smooth cream and then diluting to the desired concentration. Usually use 1% solutions but the activity of the product will govern the concentration to use.

Test: Into a series of the "test" tubes brought to 40° C. in the water bath varying amounts of enzyme are added at 30 or 60 seconds intervals, starting watch at the shaking of the first sample. After all the enzyme aliquots are added the series of test tubes are shaken a second time. The digestion time is 30 minutes.

Iodine Solution: 3.0 c.c. of N/10 iodine in 900 c.c. distilled water is cooled to 21-25° C. 50 c.c. of this dilute iodine is placed in each of seven flat bottomed Nessler tubes a few minutes before the end of the reaction time.

End point: At about 29:15 minutes after starting, the first sample is removed, shaken and 0.1 c.c. pipetted into the 50 c.c. of iodine solution at exactly 30 minutes (touch the tip of the pipette on the side of the tube.) If no color develops, the starch has been completely digested. If blue color develops insufficient enzyme has been used. The end point is the tube with the least enzyme that shows no red or blue coloration.

Calculation: Find the number of milligrams of dry enzyme used in the end point volume. Each tube contains the equivalent of 250 milligrams of starch. The U.S.P. value is the number of milligrams of starch split by one milligram of enzyme.

$$\frac{250}{\text{mgms. of enzyme}} = \text{equal U.S.P. Value}$$

Comment

Whole potato starch is used and, as there is no attempt to control the pH of the substrate, the assay will vary from starch to starch. Likewise, there is no addition of salt, so necessary for the proper action of pancreatic enzymes, although this lack would not be fatal in the case of evaluation of bacterial and plant enzymes. It is conceivable that a pancreatic enzyme of high potency, if the salt normally present in the untreated gland had been removed substantially during the process of manufacture, might show a very low degree of activity by this method. The end point is also very unsatisfactory and can only be read consistently by an experienced operator.

3. Method of determining the reduction sugars formed from 2% soluble potato starch by the action of enzymes.

Starch: Use 100 c.c. of 2% soluble starch that has been buffered to the desired pH. Weigh equivalent of 10 gms. dry soluble potato starch into 100 c.c. beaker and add 50 c.c. distilled water and work to a smooth cream. Place 200 c.c. of distilled water in a liter Erlenmeyer flask and heat almost to boiling, remove from flame, wash starch suspension into hot water with a few c.c. of distilled water and bring to a boil and boil 3 minutes. Cover flask and cool to room temperature. Add 25 c.c. 0.4M NaCl solution, 8 c.c. 0.4M Na_2HPO_4, and 4.5 c.c. 0.4M NaH_2PO_4. Make up to a final volume of 500 c.c. with distilled water and mix well.

Pipette 100 c.c. into 200 c.c. Erlenmeyer flask and bring to temperature in the 40° C. water bath.

Enzyme Solution: Use enzyme solution of desired concentration, usually 0.1%.

Reaction Mixture: Prepare sample by adding 5 c.c. of the enzyme solution of the starch suspension that has been brought to temperature in the 40° bath, digest exactly 30 minutes, and stop the reaction by the addition of 10 c.c. of N/5 NaOH solution and remove from bath.

Titration: A.O.A.C. Fehling's solution is used. For each test, 5 c.c. of each of the solutions and 10 c.c. of distilled water are mixed in a 200 c.c. Erlenmeyar flask. Mix well and place over flame to boil at a moderate rate. Boil 2 minutes and add 3 drops of a 1% aqueous solution of Methylene Blue. Continue boiling and complete titration with reaction mixture (while boiling constantly) to the removal of the blue color and record the total volume of the reaction mixture used. If more than 2 c.c. are required for the final titration, it is advisable to re-run sample, adding more reaction mixture before starting the heating. The complete boiling time should not exceed 3 minutes.

Calculation: The Fehling's used is equivalent to 80 mg. maltose. The total volume of the reaction mixture is 115 c.c. If the end point is reached with 18.4 c.c. for the reaction mixture, the value is calculated as follows: Total maltose formed would be 80:18.4 as X:115 or 500 mg. maltose. Enzyme solution used had 1 mg. per c.c. and we used 5 c.c. and the activity would be expressed as 100 times its weight of maltose formed.

Fehling's Solution: Prepare by mixing immediately before use equal volumes of (A) and (B).

(A) Copper sulfate solution. Dissolve 34.639 gms. of $CuSO_4.5H_2O$ in water, dilute to 500 c.c. and filter through asbestos.

(B) Alkaline tartrate solution. Dissolve 173 gms. Rochelle salts and 50 gms. NaOH in water and dilute to 500 c.c. Allow to stand 2 days and filter through asbestos.

Check Fehling's solution from time to time by use of known maltose solution.

Comment

This method is probably more useful where the enzyme is being used for the production of sugars from starch substrates, an intermediate step in the manufacture of alcohol.

The difficulty with this method seems to be the obtaining of reproducible results, particularly from one laboratory to another. The necessity of boiling the Fehling solution makes the operation very awkward for any but the most experienced chemist.

I am told that a newer modification of this test that gives much more dependable results.

4. The Wohlgemuth test using 1% soluble potato starch.

Starch: Weigh equivalent of 5 gms. dry soluble potato starch into 100 c.c. beaker and add 50 c.c. distilled water and work to a smooth cream. Place 200 c.c. of distilled water in a liter Erlenmeyer flask and heat almost to boiling, remove from flame, wash starch suspension into hot water with a few c.s. of distilled water and bring to a boil and boil three minutes. Cover flask and cool to room temperature. Add 25 c.c. of 0.4M NaCl solution, 8 c.c. 0.4M Na_2HPO_4, and 4.5 c.c. 0.4M NaH_2PO_4. Make up to a final volume of 500 c.c. with distilled water and mix well.

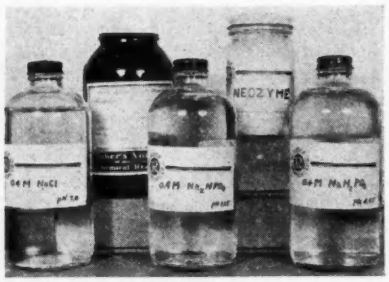
Enzyme: Prepare 100 c.c. of a suitable concentration, usually 0.1% concentration.

Test: Have a number of test tubes in basket in ice bath. Add varying amounts of enzyme solution to the tubes carefully, avoiding contact with the sides of the tubes. Add 5 c.c. of starch solution carefully. Shake the baskets and tubes horizontally vigorously. Place in 40° C. bath, starting watch. At end of 30 minutes remove the basket and place in the ice bath. Add 1 drop of N/10 iodine to each tube. Dilute with water to a volume of 15-20 c.c.s. Shake well and compare colors. The end point is a definite red.

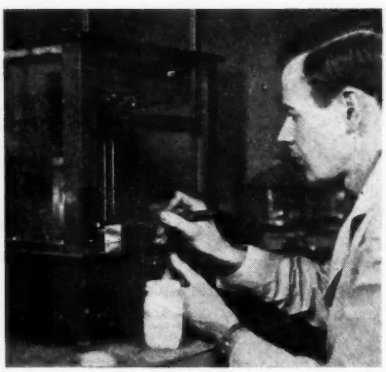
Calculations: Find the number of milligrams of dry enzyme used in the end point volume. 5 c.c. of 1% starch equals 50 mg. starch. The Wohlgemuth value is the number of mg. of starch split by one mg. of enzyme.

$$\frac{50}{\text{mg. enzyme}} = \text{equals value.}$$

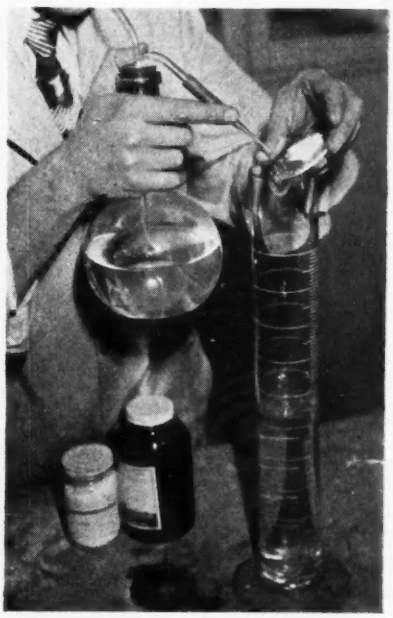
Method of Evaluating Enzymes



A. The chemicals used.

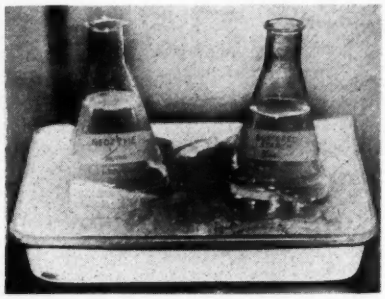


B. Accurate weighing is essential.

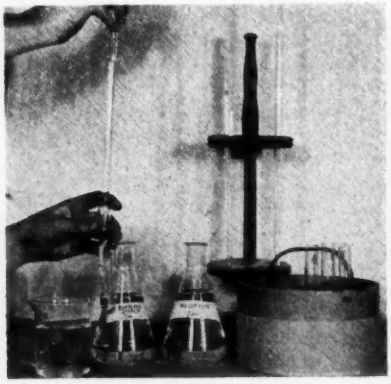


C. The Starch is pasted with cold water 50-100 c.c., 5 grams starch. The enzyme is washed into cylinder with cold water.

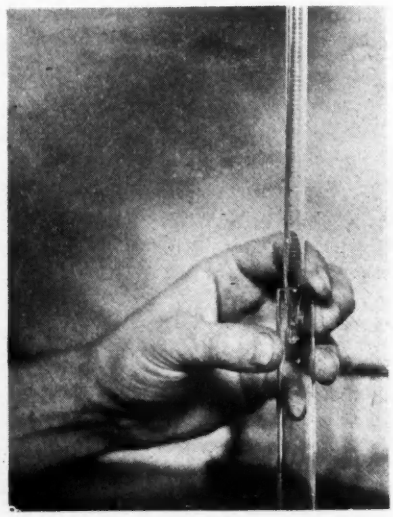
D. The pasted starch is washed into 200 c.c. boiling water. As soon as ebullition is resumed, boiling is continued for exactly 3 minutes, accurately determined by stop-watch, cooled to room temperature and correct amounts of buffering agents added. Make up to 500 c.c.



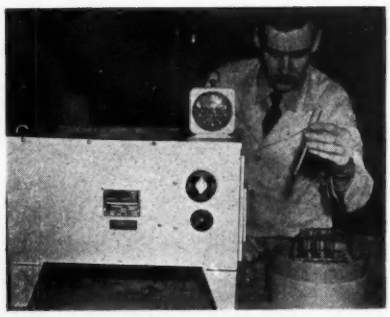
E. Both these standard solutions are kept on ice. They are good for one day only.



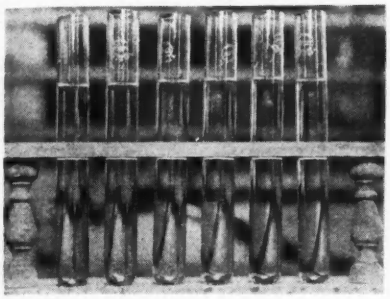
F. Six clean test tubes are placed in the ice bath and thoroughly cooled; then the necessary amounts of starch and enzyme are pipetted into them.



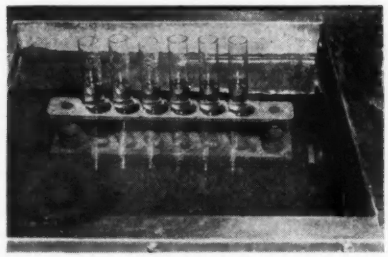
G. Extreme care is necessary in this operation to prevent splashing of either ingredient on the walls of the test tubes.



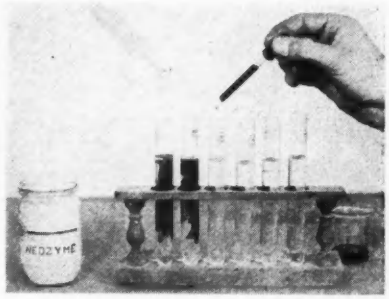
H. After adding the extra c.c. of water to bring all to constant volume the test tubes are transferred to the constant-temperature water bath and the stop watch is started.



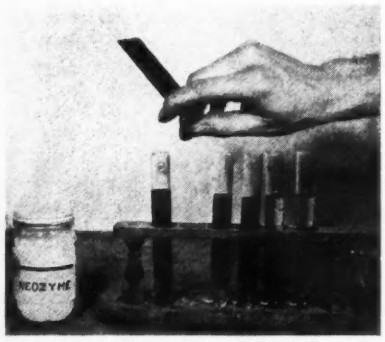
J. At the end of the period of treatment,



the rack of test tubes is removed from the water bath and plunged into the ice water bath. After cooling five minutes, 5 c.c. of ice water is added to each.



K. One drop of N/10 iodine is added to each.



L. The tubes are agitated, the thumb being dried after each shaking. After wiping the dew from the outside of the tubes, the colorations are compared.

In order to check the standard enzyme, a trial is first made, using the minimum amount of enzyme known to fully convert the 5 c.c. standard buffered 1% starch solution in 30 minutes at the optimum temperature. One tube is removed from the constant-temperature water bath every five minutes and immediately plunged into the ice water bath. Five minutes after the last one has been removed, the volumes are made up to 20 c.c. with ice water and one drop of N/10 iodine added. After shaking, the colorations are observed. They should be characteristic for the particular enzyme being examined. In the case of pancreatic enzyme, the colors should run:

After 5 mins. .....Blue
After 10 Mins. ...Blue Purple
After 15 mins. ....Red Purple
After 20 minc. .....Red
After 25 mins. .....Orange
After 30 mins. .....Colorless, or very slightly yellow.

If the colorations follow this pattern, it may be assumed that the standard solutions are in order.

Comment

This is the method we have found easiest to operate and the results are reproducible within reasonable limits. However, it was found necessary to make certain changes in the interest of accuracy.

Our modification is as follows:

In the standard Wohlgemuth test, each contains a different total amount of liquid. 5 c.c. of starch are used in each tube and 1, 2, 3, 4, 5, 6, c.c. of enzyme are added. Thus the totals are 6, 7, 8, 9, 10, and 11 c.c. respectively. We know that concentration is one of the factors affecting enzyme activity. So, the necessary amount of water is added to each to bring them all up to 15 c.c. Then again, it is important that all the substrate shall be in contact with all the enzyme. The most minute amount of starch remaining on the walls of the tubes will affect the coloration produced when the iodine is added. For this reason, the starch is added first, taking care that it is put into the tube in such a way that none of it is splashed on the sides. Next, the enzyme is added just as carefully, after which the make-up water is run down the sides of the tube, so that, if any of the two essentials have splashed on to the sides, they will be washed down. The shaking is dispensed with, as the convection currents set up in the liquid in the tubes, as soon as they are plunged into the hot water bath are sufficient to thoroughly mix the ingredients.

The extra water is a convenient carrier for any other additions of materials it is desired to make in order to test as to suitability for use in the desizing bath, accelerators, stabilizers, wetting agents, etc.

For the benefit of those who desire to learn more about enzymes, the reading of the following books is recommended:

"Biochemical Catalysts in Life and Industry". Author, Effront. Publisher, John Wiley & Sons.

"The Chemistry of Enzyme Reactions". Author, Falk. Publisher, Chemical Catalogue Co.

"Enzyme Actions and Properties". Author, Waldschmidt. Publisher, John Wiley & Sons.

"Enzymes". Author, J. B. S. Haldane.

"The Nature of Enzyme Action". Author, Bayliss.

"Enzyme Technology" and "Enzyme Chemistry". Author, Henry Tauber,. Publisher, John Wiley & Sons.

"Enzymes and their Role in Wheat Technology". Editor, J. Ansel Anderson. Publisher, Interscience Publishers, Inc. (In this book, the sections on "Amylases" by Mary L. Caldwell and Mildred Adams, and "Proteases" by A. K. Balls and Marian W. Kies are particularly interesting).

ANNUAL
CONVENTION
Oct. 23, 24, 25
Congress Hotel
Chicago, Ill.
Auspices:
Mid-West Section

A Method for Recording the Strength of Scouring Solution in Continuous Cloth Scouring*

RALPH E. HALE

Chief Chemist, The Bell Company, Worcester, Mass.

FOR successful operation in any continuous process it is imperative to know exactly what is taking place at all times.

We have passing through our Riggs and Lombard continuous washer a wide range of fabrics, which have various weights, constructions, colors, milled or clear finish to name only a few of the variables.

To take full advantage of our continuous washer it can easily be shown that no one concentration of scouring solution will serve best for all the fabrics we desire to process.

From an analysis of the information obtained from hundreds of titrations with standard acid on samples taken from all the scouring and rinsing tanks; from a qualitative estimation of the amount of solution counter flowing and from the percent extractable of the material processed, the following was established:

1. That all the piece goods can be grouped into several classes for processing in the continuous washer and each class will use a different concentration of our standard concentrated scouring solution.

2. That the concentration of the scouring solution should be controlled in the one tank in which the standard concentrated scouring solution is admitted to the system. For if this is done the concentrations in the other tanks will take care of itself.

The problem is, how are we to maintain the desired concentration in this tank?

The variables which come from taking full advantage of the solutions counter flowing, makes it impracticable to add any given amount of standard concentrated scouring solution per unit of time.

The first control was to titrate a series of 6 to 8 samples of the scouring solution taken from the tank at which the standard concentrated scouring solution is added to the system at 10 minute intervals. This was done with each operator so that they could see when they had things operating satisfactorily. To have a technician constantly making the necessary titrations was impractical and the only thing we could do was to make this test periodically. The need was urgent to find an improved method.

By taking samples of this solution at still more frequent (two minutes) intervals and titrating them, it was observed that as the strong standard concentrated scouring solution was added in varying amounts we had a definite change which was of the same character whether the samples were taken early in the morning or late at night. This indicated that what buffering there was might be negligible and it was thought that the strength of the scouring solution might be related to its conductivity.

An instrument manufacturer was contacted and they were very pessimistic about our chances of making conductivity measurements. Even with this uncertainty they offered to lend us a portable Wheatstone Bridge and cell to make a study of the properties of our scouring solution.

Tests Carried Out

The following tests were carried out for each sample tested:

1. Titration of 100cc with standard sulfuric acid.
2. Temperature in degrees Fahrenheit.
3. The conductivity in Ohms resistance.

The indicator used in making all the titrations was Bromcresol-Green, PH range 4.0-5.6. The reason why this one was selected is that it has a sharp color change from a bright blue to a bright yellow. Of all the indicators tried, this was the only one that gave excllent check titrations with the colored scouring solutions.

Each resistance measurement, before plotting against the results from the titration had to be corrected to one standard temperature because there is a 1.2% error for each degree Fahrenheit variation. For example, if you selected 100° F. as your constant temperature and you had a temperature of 102° F. when the measurement was made, you would subtract 2.4% of the measured resistance to obtain the correct figure or if the temperature was only 98° F, you would add 2.4%.

Upon plotting the corrected measured Ohms resistance against the percent of standard concentrated scouring solution, Figure No. 1 was obtained. The observations plotted on this curve were taken on four different days at various times during the 16 hour period which the machine operated. The points for each day are plotted with a different type of point and you can see that they all fall on the same curve. When the logs of this data were plotted, a straight line was obtained.

Instrument Installed

With it established that we could measure the conductivity of the solution satisfactorily, and this was definitely related to the strength of the scouring solution, the following instrument was installed; a Model S Micromax Indicating Recorder, Type A-C Wheatstone Bridge, single point curve drawing. Its range was 1100 to 100 Ohms measured resistance at 77° F. with a 1.0 reciprocal centimeter cell constant. This recorder is mounted so that the operator can see the indicating pointer the entire length of the washer.

A measuring conductivity cell is used and briefly it is about 20" long with the electrodes enclosed in a 15" open end glass case. These electrodes are plated with Platinum Black.

When the instrument was first installed, it was advised that the cell be located in a small wooden tank so that the suds would not cover the top, as it is not moisture-proof. It was also necessary to keep the elctrodes wet at all times. This small tank was 18" deep, 6" wide by 10" long with a weir 12" high from the bottom

* Presented at meeting, Northern New England Section, March 21, 1947.

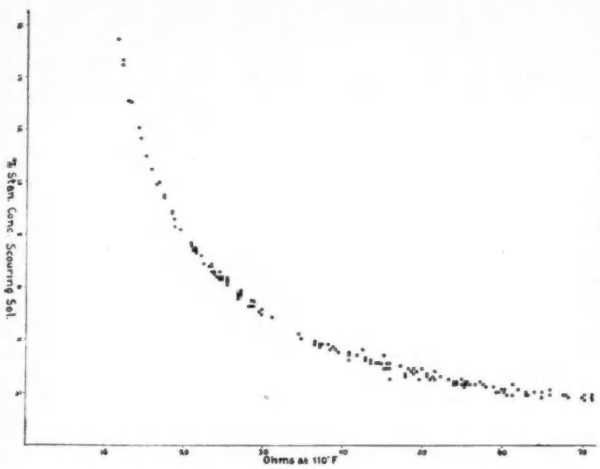


Figure 1

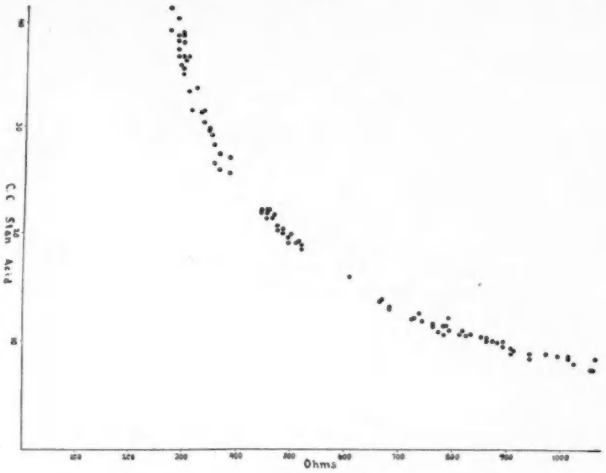


Figure 2

dividing the tank. Five gallons per minute of the scouring solution was pumped past the electrodes and this was admitted at the bottom of the small tank so that the solution as it passed up and over the weir would give the best possible circulation past the electrodes. It is advisable that the elctrodes be at least 4″ away from any grounded metal and be immersed to a depth of at least 10″.

Cell Located in Scouring Tank

This set-up gave very satisfactory results for over a year, but it was thought that an improvement could be obtained if the cell could be located in the scouring tank.

The instrument people had developed a new cell which had a glass top which was easily sealed to keep out the moisture from the suds. The first thing that was tried was to find out whether the accuracy of the cell would be changed if it dried out whenever the tank was dumped. For three weeks this was tested by removing the cell and letting the electrodes dry over night. The results were excellent.

The cell in use was in good condition so it was decided that an effort should be made to see if it could not be adapted for use in the proposed new location. This was done by sealing the top with several heavy coats of one of the new moisture-proof ignition sealers. The cell was placed inside a holder made from a piece of 3″ diameter hard rubber pipe with a screw cap and a small hole on one side near the top for the wires to the recorder to pass through. The electrodes extend 4″ below the bottom of the pipe. This arrangement has been in operation for a month with a marked improvement in the results.

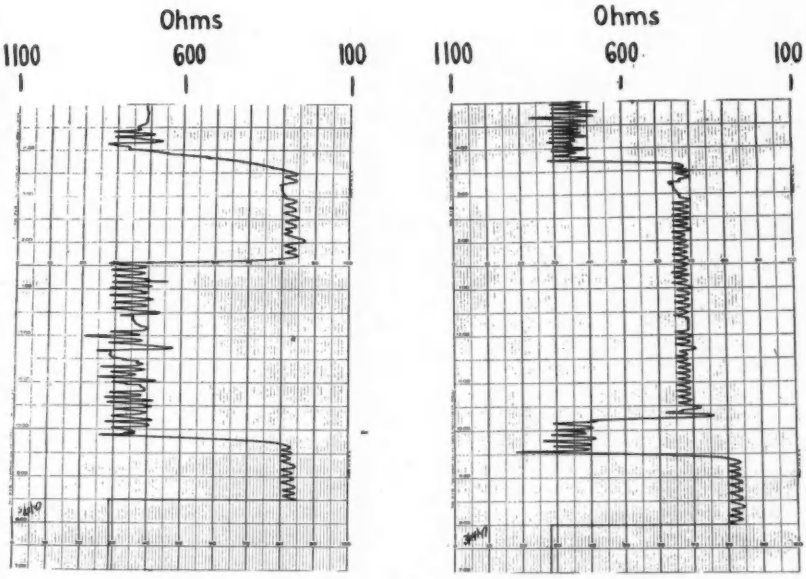


Figure 3

We tell whether this instrument is working correctly by starting a new curve, and this is done by plotting cubic centimeters of standard acid against Ohms resistance as recorded by the instrument. After the pattern of this curve is established, it is very easy to tell whether everything is working correctly. This is done by taking a sample noting the Ohms resistance at the time the sample was taken and then titrating 100cc of the sample with standard acid. Figure No. 2 shows how the points from these tests have lined up during the first 15 months that this instrument was in operation.

It was predicted that the electrodes would require frequent replating, but the tests were satisfactory for 14 months at which time they were replated to see whether it would make any important change. Of course, when one re-plates it will very likely change the location of the curve either up or down. For small changes instead of changing the length of the electrodes to bring the curve back to the original location the small temperature compensator located inside the recorder can be used. A switch is located on the recorder so that the operator can turn off the instrument before he dumps the scouring tank and he does not turn it on again until the scouring tank is ready for use. This prevents the instrument from operating at either of its extremes. This, we believe, has been one of the reasons we have had such

accurate results from it with so little attention.

Figure No. 3 shows some of the charts taken from the recorder. The lines produced are wavy because the operator adds a certain number of gallons of the standard concentrated scouring solution periodically as needed.

As an example, for the particular pieces passing through the continuous washer it is desired that the indicating pointer be held between 700 and 800 Ohms. When the pointer reaches 800 the operator adds 5 gallons of the standard concentrated scouring solution. In less than 30 seconds the pointer will start moving toward 700. Between 250 and 300 Ohms they will be adding 20 gallons of the standard concentrated scouring solution for each addition and you will note the much smaller left and right variation. It is very essential that the standard concentrated scouring solution be well distributed when added in order to obtain this uniform left and right movement of the pointer.

It is not considered necessary to go further and add an elaborate control system for the continuous addition of the standard concentrated scouring solution since no need exists for making a further improvement in the results.

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Post-War Textile Processing—

(Concluded from Page P351)

treatment and tried to nap them, but they could not do as good a napping job as with untreated cloth. It would have to be done to the goods after napping.

Mr. Redmond: Does that mean there would be a drop in the tensile strength of any fabric treated with the Ban-flame treatment?

Mr. Jacoby: I do not think so. This taffeta here (illustrating) is certainly very, very strong. Here is a pigmented rayon, and here is a spun rayon both treated. I would say that if you have any strength left after that golf match, it is going to take a lot of tugging to break these samples.

Mr. Christison: I was rather intrigued with the use of the words "colored" and "dyed." I am a little bit confused. When is a fabric colored, and when is it dyed?

Mr. Jacoby: It is difficult to draw a definite dividing line. In the case of direct colors where we follow a normal dyeing procedure, we get the shade we expect of the dyestuff. However, if the color is simply padded on and the goods dried immediately it is nowhere near the true shade. I would say, therefore, in that case, that the goods are not dyed until they reach the correct shade. There is also the question of fastness properties as shown on these Fade-Ometer Test cards.

With vat colors, you have a different proposition. If you applied a vat color reduced, and oxidized and dried it at once, you probably would have the true shade, whereas you would not have the fastness properties. That is why these pad-steam units are being used when the vat color is padded on reduced, and then the goods are steamed, so as to affect dyeing.

All I can do is give you my personal opinion, and I would say that dyeing would be when the true shade was reached and the true fastness properties were reached. Up to that point, the goods are colored but not dyed.

Mr. Copley: I wanted to check a statement you made regarding a fifty piece wool kettle. Was that a conventional machine? It was something I never heard of.

Mr. Jacoby: In the conventional type kettles, the largest I know of are ones which hold 2,000 pounds of goods so, of course, the number of pieces will depend upon the weight of the goods. There is also the multi-kettle unit which consists of from one to six units connected together.

Chairman Linberg: Before you go, Mr. Jacoby, I would like to have you give us some of the faith that these scientists had in the possibility of an atomic bomb. Will it be five or ten years from now, when we will have a material that will not shrink, will not burn, will not spot and will not shine?

Mr. Jacoby: I left my crystal ball home, so that I cannot answer that one!

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CALENDAR

PHILADELPHIA SECTION
Meetings: September 26, November 8, January 16, 1948, February 27, 1948, April 9, 1948, May 21, 1948 (Bellevue-Stratford Hotel, Philadelphia).

NORTHERN NEW ENGLAND SECTION
Meetings: September 26, November 21.

NATIONAL CONVENTION
October 23, 24, 25 (Congress Hotel, Chicago).

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EMPLOYMENT REGISTER

This column is open for four insertions per year, per member, without charge. Blanks can be obtained from, and filed with, the Secretary of the Association, Lowell Textile Institute, Lowell, Mass. It is understood that these will be open to inspection by prospective employers, who can obtain further information through the code numbers from the Secretary.

47-27

Education: Graduate Pratt Institute, additional college training.
Experience: Twenty years research, development, control; biochemistry, intermediates, dyestuffs.
Age 44; married; references.

47-29

Education: Equivalent of two years college in Germany, and Textile College in Czechoslovakia; also commercial background.
Experience: Finishing, dyeing and laboratory testing in Europe and India; specializing in worsteds, woolens and mixtures; production control.
Age 31; married, has received first papers for U. S. citizenship. Work in metropolitan area preferred; will train, with chances of promotion.

47-30

Education: Graduate, Bradford Durfee Textile Institute.
Experience: Dye laboratory, executive management of dyeing and finishing, various threads, cotton goods, printing.
Age 38; married; references.

47-31

Education: B.Sc. & M.Sc., Philadelphia College of Pharmacy & Science.
Experience: Research chemist, Director of Research & Quality Control, surgical and textile goods.
Age 33; married; references.

47-32

Education: Textile Chemical Engineer, State College, Austria.
Experience: Dyeing and finishing on a variety of fibers and products with executive responsibility, development and sales promotion.
Age 31; married; references; New York City or West Coast preferred.

47-33

Education: Graduate vocational school, with additional college courses in chemistry.
Experience: Laboratory dyeing and testing; dyer of yarns and hosiery with executive responsibilities in dyehouse.
Age 31; married; will go anywhere in U. S.; New York area preferred because residence available.

ABSTRACTS FROM CONTEMPORARY JOURNALS

Soaping of Rayon Prints

"Technicus", Silk Journal and Rayon World, page 34, Vol. XXIII, No. 271, December, 1946.

The main objectives in the soaping of print goods are the removal of surplus thickening and unfixed dyestuff. Good solubility and easy removability of thickenings are necessary in order to obtain the full effect of soaping treatments.

The ordinary commercial soaps may be termed anion soaps, the positive ion being the metallic radicle and the negative ion the long chain constituent. To avoid insoluble soaps caused by the presence of metallic salts a soft water supply or treated water must be used.

Open width washers and rope washers are in general use for rayon print soaping. Tension should be avoided with both types. Information on the use of these washers is given.

The development and soaping of vat colors printed in a medium-weight pattern on a spun rayon fabric is discussed.

Wet marking-off faults occurring with vat colors should be avoided by preventing piling up of the prints and by proper control of the prints entering the developing liquor. Dry material should not be run so close to wet out pieces as to allow marking-off. Wet marking-off can usually be removed by vigorous after soaping.

Fast colors may be treated in boiling soap liquors. Desizing may be carried out between oxidation and final soaping. Screen prints require more soaping than corresponding patterns produced by roller printing.

Dan River Completes Research Organization

C. Mallard Bowden, Textile World, page 104, Vol. 97, No. 3, March, 1947.

Commercial results of Dan River's research program so far are a number of new textile processes centering around the application of natural and synthetic bonding agents to textile fibers, slivers, rovings, yarns and fabrics. New dyeing processes and other developments are either in use or nearing completion.

Supplementing the Research Engineering Division laboratories are a number of technical control laboratories located at strategic points throughout the mills. New sales fabrics are originated in the Designing Department which is affiliated with the Research Engineering Division.

Projects now in process are chemical transformation of the cotton fiber; further development and application of synthetic resins; new processes in dyeing and finishing; and the preparation of textile materials for bleaching, dyeing, etc.

The Phase-Contrast Method and Its Applications in Microscopy

A. Kohler and W. Loos, Textile Research Journal, page 82, Vol. XVII, No. 2, February, 1947.

This paper is summarized as follows:

The phase-contrast method is a development of the Abbé theory of microscopic representation in which an increase of the contrast in the microscopical image is attained by influencing the phase of a part of the light. The theoretical basis of the phase-contrast method is discussed in detail. The use of circular, ring-shaped phase platelets is noted.

Differences between bright field and dark field and between positive and negative phase-contrast are reviewed. The superiority in many cases of the phase-contrast method over dark field and light field methods are discussed and examples given.

Some Comparative Data on the Cross-Sectional Swelling of Textile Fibers

Frederick F. Morehead, Textile Research Journal, page 96, Vol. XVII, No. 2, February, 1947.

Most fibers swell in cross-section more than in the longitudinal direction.

The data presented in this paper were obtained by measuring the increase in area of the fiber cross-section when swollen in water. Area measurements were made from photographs of the same fiber in both the wet and dry condition. The procedure used in this study is given in detail. Cross-sectional swelling data for animal, synthetic and cellulose fibers are tabulated.

The Fastness of Dyestuffs and Dyed Materials

"Kemmek", Textile Recorder, page 52, Vol. LXIV, No. 764, November, 1946.

Practical tests which indicate dyestuff fastness properties are of considerable value to the dyer.

Easily performed tests which provide an idea of the fastness properties of a dye to milling and washing are given. Tests are also included for chlorine, lime, alkali and acid fastness.

Fastness to acids and alkalies act as a good guide for the fastness to carbonizing. However, a more critical test for this particular property is outlined in detail.

In addition to the "blow" test, an absorption test is included to determine whether a dye is a mixture or homogeneous.

Washing Rayon Prints

"Technicus", Silk Journal and Rayon World, page 46, Vol. XXIII, No. 273, February, 1947.

The acid and direct colors used in the urea process of printing on viscose and allied fibers usually have inferior washing fastness. The wash fastness depends upon the original properties of the dyestuffs, the fixation of the dyestuffs in steaming after printing and the solubility of the thickening used.

Soluble thickenings such as tragacanth and locust bean are very suitable. Large amounts of running water are necessary. Slack washing in the rope state is used. Small amounts of sodium hydrosulfite "kill" residual dyestuff in the wash water and clear up slightly tinted whites.

A continuous method of washing and dyeing is described.

Cellulose acetate dyestuffs give good results when printed by any method using vegetable mucilages as thickeners. However, precautions are required in washing. The washing process for white and color discharges on cellulose acetate is given.

In all wash-off processes with prints produced on direct dyed grounds the use of a cation active compound is recommended to prevent the bleeding of dyestuff into the white discharge.

The washing of printed silk materials is discussed.

Rule of Thumb in Scouring Coming to an End Under Impact of New Knowledge; The Blessing of pH Measurement

The Dyer and Textile Printer, page 71, Vol. XCVII, No. 2, January 17, 1947.

Past improvements in scouring have been mostly on the machine side rather than in the actual scouring process. Soap and alkali are commonly accepted materials for wool scouring. Better cleansing methods will require further research work.

pH measurement in scouring has brought forth considerable information on scouring baths. Conditions within the bath may be determined during the scouring operation by means of pH measurement. pH measurements show the optimum condition of a soap for scouring effect is at 10.7. Stained acid milled fabrics must be made alkaline in order to treat with soap and alkali.

Electrical charges on suspended particles are an important factor in the scours now used.

• PATENT DIGEST •

Stiffening Felt Hats—Zein solutions G, 1

U. S. P. 2,413,229 (John B. Stetson Co., Hodshon-Tucker, Dec. 24, 1946)

Heretofore shellac has been widely used as a stiffening agent for felt hats. During war time shellac was not obtainable and many other felt hat finishes had to be tried out. The specification discloses that *zein* dissolved in alcohol or in another organic solvent does not only stiffen felt hats quite as good as shellac-borax solutions but that it also makes the hat body more resilient and gives it a better "snap-back" property than shebllac finishes. It has further been discovered that additions of rosins dispersed in water by caustic soda (or ammonia) have the result of increasing this effect and to make it more permanent.

Reference: Zein has been used for obtaining permanent finishes by mixing it with ammonia soap and later volatilizing the ammonia (U. S. P. 2,377,237 Corn Products Ref. Co.) or by dispersing it with sulfonated oils, sulfated alcohols (Corn Prod.). American Maize suggested in U. S. Pat. 2,340,913 to dissolve zein in shellac or other rosins for finishing purposes.

Textile Lubricants—Alkylphosphoric acid compounds A, 7, 01

U. S. Pat. 2,413,428 (Monsanto Chem. Co. Billings, Dec. 31, 1946)

Fiber lubricants, used in different textile processes such as weaving, knitting and the like, have the purpose to minimize fiber breakage and to act as an adhesive preventing fly in carding operations. Mineral oils, olive oil and some other glycerides have been proposed. The inventor found a particularly suitable composition for lubricating fibers in applying alkaline salts and alkylolamine salts of lower alkylphosphoric acids. These salts are water soluble and give neutral or slightly alkaline solutions. The pH is between 6 and 10. They can easily be removed afterwards without using soaps, they are positively hygroscopic, i.e., they do not dry out and their almost neutral condition prevents damages on textile fibers. An example is sodium-potassium ethyl phosphate. The best conditions of applying these lubricating solutions are 40% relative humidity at 70° F.

Reference: Arylphosphates mixed with glycolethers as lubricating agents (U. S. Pat. 2,395,380, Cities Service).

PAUL WENGRAF

Pigment Printing—Partially gelled resin solutions D, 2, 07

U. S. P. 2,416,620 (Interchem. Corporation, Gans-Adams, 2/25/1947 applic. May 28, 1941)

The first patent dealing with the new printing methods of the Aridye type has been issued under the number U. S. P. 2,222,581, 1940 (Jenett—assigned to Interchemical Corporation). It described pastes in which an outer, water-insoluble ("Lacquer"—) phase is thickened by an inner aqueous phase which is at least 20% of the emulsion. Preferably the binder for the pigment is a condensate, originally soluble in an organic solvent and converted after printing into an insoluble state. It has now been discovered that pigmented pastes of this type can be remarkably improved by converting the resin solutions, used in this process in a state of partial gelation. In this condition the resin solutions appear as a thick liquid mass in which smooth gelatinous particles are dispersed. According to this method the amount of water added can be reduced or the water can be omitted. The partial gelatination is brought about by different means: in one of the examples an alumina—aerogel is dispersed in the paste, causing by its great surface a quicker gelatination of alkyd- and urea-formaldehyde resins present. Another component for accelerating the gelatination's process has been found in trichloroacetic acid. Despite this gel-like consistency the printing ink works very well in printing textiles from engraved rollers. It separates easily from the cells of a regular intaglio engraving.

Delustering—Urea-formaldehyde condensates F, 3, 02

U. S. Pat. 2,416,988 (Tootal-Broadhurst-Lee-Fould-Marsh, March 4, 1947, applic. Oct. 11, 1941)

According to the present invention a delustering process is carried out by applying urea formaldehyde condensates. The method is characterized by a two-bath process instead of working with one solution, containing both of the ingredients in the same bath. The advantage has to be seen therein that the urea solution, forming the first bath is completely used up while in the one-bath process always some methylolurea is already formed and precipitated. A better control of the operation is claimed. Moreover a preparation with urea alone allows many variations in the printing technique such as plain resists, colored resists, cross-prints and the like. The claims relate to the two-bath process while many of the examples disclose another variation, i.e., to impregnate with a *neutral mixture* of formaldehyde and urea and to develop in acids.

References: U .S. Pat. 2,302,778-79 (Ciba Company) suggestel to use urea-formaldehyde resins, dissolved in strong acids and diluted with cold water as delustering agents. The assignee was granted the Brit. P. 499,207 relating to an impregation with a urea-formaldehyde pre-condensate, to squeezing out and aftertreating with dilute hydrochloric acid. Also Brit. P. 435,868 (Cal. Printer's Ass.) described a delustering process carried out in a one-bath or a two-bath operation with condensates of urea-formaldehyde or dicyandiamide-formaldehyde.

Printing Multicolor Relief Designs D, 1

U. S. Pat. 2,416,997-98 (Aspinook Corporation, Hewitt, March 4, 1947, applications May 26, 1946 and March 24, 1944)

Conventional printing methods aim to produce one- or multi-color designs in one plane while the present patents describes a way to obtain *multicolor effects in relief.* The principal idea of this invention is based on a *colored shrinking resist,* used for one part of the design while the remaining printed areas are illuminated in contrasting colors. In a subsequent shrinking process the resist printed portions are bowed out of the plane of the fabric while the parts, free of resist ,contract. The effect is preferable brought about by using a cellulose resist giving the fabric a sufficient body so that it will bow rather than pucker as frequently observed in creping operations. So for instance the petals of a flower design may contain a resist, the leaves are resist-free. The prints are aged in the usual way and passed through a mercerizing bath without any tension. The invention is illustrated by the description of a vat-printing process. The second namel patent relates especially to the composition of the resist. It has been found that cellulose-zincate solutions, as described in Edelstein's U. S. Pat. 2,322,427 for permanent finishes, partly also for printing pigments are especially suitable for forming the print-resist. It has been observed that these cellulose zincate so-

lutions can best be prepared from a sulfuric acid degraded cellulose by digesting cellulose with 0.5% sulfuric acid and 0.5% alkali dichromate.

References: Shrinkage-resists, consisting of acetate-cellulose containing pastes are described in Heberlein's U. S. Pat. 2,382,416. They are applied before mercerizing the textile goods. Another U. S. Pat. 2,075,695 (Heberlein-Bodmer) suggests to dissolve cotton linters in cuprammonium and to print this solution as a resist under a parchmentizing acid. The sulfuric acid penetrates this resist as well as the unprinted areas; therefore the fabric has throughout the same hand and a local delustered effect in midst of a transparentized ground.

Bleaching Textiles—Alkaline stannates added B, 1

U. S. Pat. 2,417,570 (Solvay Process Company, Rogers, March 18, 1947, applic. Sept. 3, 1943)

Improvements in bleaching cellulose with hypochlorites are obtained by adding very *small quantities of alkali stannates* to the bleaching liquid. The quantity of stannate may vary between 0.10 and 2.0 g. in one liter. The degradation of cellulosic material is diminished (measured by comparing the respective fluidities of cuprammonium cellulose solutions prepared from the bleached material) and superior whites are produced.

References: Small catalytic acting salt solutions in bleaching processes are for instance Cobalti acetate (Ger. P. 706,526-I.G.) Alkali stannates are used according to Ger. P. 722,096 (Rotta & Quehl) for producing crease-resistant finishes and, according to Roessler-Haslacher's Brit. P. 409,361, as stabilizing agents for peroxide solutions.

Cellulose Zincate Solutions—used in transparentizing printing operations D, 1

Brit. P. 581,436 (Heberlein, Oct. 11, 1946; applic. May 3, 1945—Swiss pr. May 4, 1944—Parallel Swiss patent 243,583)

It is known to render cellulosic fabrics *translucent* by impregnating them with cellulose xanthate, cuprammonium cellulose and the like, or to combine this operation with a *transparentizing* reaction using sulfuric acid of 50° Bé under carefully controlled conditions. On the other hand textile materials can be treated with a cellulose zincate solution according to one of the known Edelstein patents (for instance Brit. P. 573,768). A transparentizing finish can be applied according to the present patent in form of a cellulose zincate solution. This method has the advantage to dispense of drying the fabrics before the following mercerizing operation as required in other similar impregnations for instance with viscose or cuprammonium solutions. Moreover the cellulose zincate solution can be prepared from any cellulose material such as wood pulp, cotton linters and the like. According to an example cotton muslin is impregnated with a solution, containing 4% cellulose, 2% zinc oxide and 6% sodium hydroxide. The fabric is immediately run into the mercerizing liquid rinsed with hot water and dried. A transparentized but only slightly stiffened fabric is obtained.

Reference: Transparentizing with zinc chloride as a swelling agent for cellulose has been proposed in the same company's U. S. P. 2,312,346, 1943. See further references to Abstract U. S. Pat. 2,416,997-98 here above.

Pigment Printings—Starch preparations used D, 2, 07

U. S. Pat. 2,413,320 (Stein, Hall & Co., Griffin-Traux-Nuttall, Dec. 31, 1946; applic. May 14, 1942)

The general application of starch as a thickening agent is based on its swellability in water, on the formation of gels by heating the aqueous suspensions and on the property of being relatively easily removed after the dyestuff applied by the printing paste has been fixed upon the fiber. The present invention proposes to use the starch in quite another field of the printing technique. The starch is here a component of pigment printing emulsions. Two modifications are possible according to this new process. In one type of the emulsion the binder—the starch compound—is contained in the aqueous phase together with an agent capable of insolubilizing the starch in a heating process (an example is here potassium pyroantimoniate) while the pigment is dispersed in the lacquer phase. The other type contains the binder in the aqueous phase as before but another oil-soluble binder is added to the lacquer phase (example a water insoluble cellulose ether or an oil soluble resin). This second type of emulsion is said to be preferred. The first type is exemplified by an aqueous suspension of starch, gum and potassium pyroantimoniate, homogenized with an oil solution of a pigment of the phthalocyanine type. An example for the second type relates to a paste composed from an aqueous starch suspension as set before while the oil phase contains an oil-soluble low viscosity cellulose ether, dissolved in Solvesso. Thus the invention combines the sharp outlines and the speedy fixation of the Aridye prints with the easy obtainable, cheap carbohydrates, particularly starch compounds as described in the examples above.

References: U. S. Pat. 2,377,709, 1945 (du Pont) recommends a method for dispersing pigments in starch thickeners by using the trisodium salts of lignin sulfonic acids. Starch is used in a modified form. A special modification called "Shopal" and manufactured by Stein Hall & Co. is recommended in this patent. U. S. Pat. 2,222,581-2 of Interchem. Corp. (1941) relates to printing process where starch thickened pastes are printed along with Aridye pastes. When parts of the Aridye printing paste are transported by the fabric into the starch paste there is generally formation of lumps but according to the patent of the Interchem. Corp. a solvent, homogenized in this starch printing paste prevents any irregularities.

Dyeing Cellulose with Acid Dyestuffs—Guanidine salts C, 4, 06

U. S. Pat. 2,417,312 (Courtaulds, Ltd., MacGregor, March 11, 1947, applic. May 6, 1944, Brit. Pr. July 22, 1943)

Brit. P. 433,143, 1935 (Ciba Company) has already suggested to treat cellulose with formaldehyde condensate with dicyandiamide, guanidine or urea in order to increase the affinity of the material to acid dyestuffs. The inventor himself obtained Brit. P. 549,214, 1942 relating to improvements of the dyeing properties of cellulose by impregnating it with formaldehyde and the guanidine salt of a long chain carboxylic acid (examples are guanidine sebacate or adipate). It has now been found that the affinity of cellulose to a great series of dyestuffs such as acid dyestuffs, chrome dyestuffs, acetate dyestuffs and even to direct dyestuffs is substantially improved by treating the material prior to dyeing with an aqueous solution of *formaldehyde plus a guanidine salt* of an unsaturated carboxylic acid and condensing both components to an insoluble substance upon the fiber. An example is guanidine methacrylate:

$$H_2N - \underset{\underset{NH}{\|}}{C} - NH_2\text{-}HOO\ C(CH_3) : CH_2$$

formed by neutralizing guanidine carbonate with an ethanol solution of methacrylic acid. A mixed fabric, containing both animalized staple fiber and wool is equally dyed in a bath of Eriochrome Azurol B.

References: Increasing the affinity of cellulose to wool dyes is obtained according to U. S. P. 2,121,337 (Gen. Aniline) by pretreating the fibers with substituted guanidines. The U. S. Pat. 2,103,587 (Calico Printers Ass.-Lantz) suggests to form for the same purpose urea-formaldehyde condensates *in situ* upon cellulosic fibers.

TRADE NOTES • NEW PRODUCTS

• Onyx Data Sheets Available

Onyx Oil & Chemical Company, Jersey City 2, New Jersey, have recently produced a series of data sheets on certain of their products. These sheets outline in detail the major uses of the product, its outstanding technical advantages, performance data, application details where practicable, and its chemical and physical characteristics. Data sheets are available on the following products:

Neutronyx 330—Sheet No. 1-T

Repel-O-Tex D3 and Repel-O-Tex D4—sheet No. 2-T

Eternalure D-15—Sheet No. 3-T

NSAE Paste—Sheet No. 4-T

Repel-O-Tex 115B Special—Sheet No. 5-T

Phi-O-Sol WA—Sheet No 6-T

Dullatone CA—Sheet No. 7-T

NCF Paste—Sheet No. 8-T

Onyxsan LG—Sheet No. 9-T

Oroset L—Sheet No. 10-T

Imularv P and Imularv S—Sheet No. 11-T

Stearo Glyceryl Sulfate N—Sheet No. 12-T

Larvonil P—Sheet No. 13-T

It is intended to issue similar data sheet on all outstanding products in the Onyx line.

• Canadian Sales for Refined Products

The Canadian Office of Carbic Color & Chemical Co., Inc., has been appointed as sales agents for the products manufactured by Refined Products Corporation of Lyndhurst, New Jersey.

The sale in Canada of the complete line of textile chemical auxiliaries will be handled under the personal supervision of J. T. Broadbent.

• Purchases Control of Union Bleachery

Operating control of the Union Bleachery, Greenville, S. C., has been purchased by the Aspinook Corporotion and its affiliated companies, it has been formally announced by William A. Broadfoot, president of the purchasing organization.

At the same time, it was announced that R. W. Arrington, former president of the Union Bleachery, has resigned his portfolio because of ill health and has been named to serve as chairman of the board of Union Bleachery.

Mr. Arrington's position will be taken over by Mr. Broadfoot, the only change to be made in the Union Bleachery management.

• Annual Meeting, PTI Foundation

The annual meeting of The Philadelphia Textile Institute Foundation was held at the Manufacturers Golf and Country Club, Oreland, Pa., June 6th, 1947.

Members of the Foundation shown in the photo above are (left to right): Everett L. Kent, President, Kent Manufacturing Co., Clifton Heights, Pa.; Carl C. Mattmann, Jr., Textron, Inc., New York, N. Y.; Edward H. Rakestraw. President, Hyde-Rakestraw Company, Philadelphia; Benjamin Gibbs, Treasurer, Gibbs Underwear Company, Philadelphia; Theodore B. Hayward, Manager Wool Dept., Swift & Company, Philadelphia; Rinaldo A. Lukens, Vice-President, Continental Mills, Inc., Philadelphia; Millard D. Brown, President, Continental Mills, Inc., Philadelphia; Lindsey H. Mason, President, S & M Dye Works, Inc., Philadelphia; Charles D. Ebrengart, President, Onyx Oil & Chemical Co., Jersey City, N. J.; W. Lyle Holmes, Jr., President, Archibald Holmes & Son, Philadelphia; James L. Shields, Treasurer, Charles J. Webb Sons Co. Inc., Philadelphia.

• Interchem Acetate Dyes

For dyeing acetate rayon and nylon, Interchemical Corporation, Textile Colors Division, Fair Lawn, N. J., announces the development of an improved line of acetate dyes, known as Interchem* Acetate Dyes. Because they are colloidized during manufacture, Interchem Acetate Dyes are said to paste quickly and thoroughly in warm water, with no undispersed particles. As a result, dye specks and redyes are minimized. Interchem Acetate Dyes can be employed for producing either self or compound shades on boxes or on jigs. Some dyes in the line are suitable also for application and/or discharge printing. The fastness properties of Interchem Acetate Dyes are similar to those of their prototypes. Dyes in this line now available include: *Interchem Acetate Blue B, Interchem Acetate Orange GL, Interchem Acetate Orange 4R, Interchem Acetate Red RN, Interchem Acetate Rubine 3B, Interchem Acetate Bordeaux B, Interchem Acetate Scarlet B,* and *Interchem Acetate Yellow G.* Additional colors in this improved line of acetate dyes will be available in the near future.

* Trade Mark.

• Du Pont Reduces Prices

Price reductions in two important groups of industrial chemicals used in a wide variety of products, including detergents, antiseptics and cosmetics, were announced recently by the Du Pont Company.

The cuts, on higher fatty alcohols and fatty alcohol sulfates, range from 3 to 12½ per cent.

The Du Pont Company said the reductions reflect the trend toward lower prices for raw materials, particularly those in the fats market.

OBITUARY

GEORGE M. MACKENZIE

GEORGE M. MACKENZIE, associated for the last 10 years as textile technician with Kali Manufacturing Company, Philadelphia, Pa., died at his home on Tuesday, May 13, 1947.

For many years he was identified with the textile industry in Pawtucket, R. I.

Mr. Mackenzie was a Mason. He was vice president of the Fairmount Park Lawn Bowling Association.

Development of Mould–

(Continued from Page 344)

Experimental Results

(a) Temperature and Humidity Conditions

Mould growth at 86°F. was most abundant with almost 100% relative humidity (Table I). There was slight growth at 80% relative humidity and none at 60%. In view of the intimation by Fargher *(9)* that *Chaetomium globosum* requires a relative humidity of almost 100% to grow actively on cotton it is of interest to note that these experiments corroborate this belief.

At various temperatures with 100% relative humidity, growth was present on the more favourable substrates at temperatures from 50-120°F. after six days. A rating of the extent of growth after three weeks is shown in Fig. 3. For each substrate there was most growth at 90 or 100°F. and little or no growth at 40°F. and above 130°F. It is of interest to note the small amount of growth on cellulose acetate rayon in comparison with the growth on cotton and on viscose rayon. The beneficial influence of acetylation in reducing the rotting of cellulose has been reported by other workers (8, 11, 19, 21). The relative occurrence of the various organisms on all substrates is given in Table II. It may be noted that growth was confined almost entirely to species of *Penicillium* and *Aspergillus* with a smaller amount of *Paecilomyces. Alternaria* sp. appeared only at temperatures from 50-70°F. and only on wood and paper. The apparent discrepancy in the curve for the wooden tongue depressor in Fig. 3 is attributable to growth of *Alternaria sp.* in containers kept at 50, 60 and 70°F.

The graphs on the differential effect of temperature and humidity (Fig. 4) are based on the total amount of mould growth on all substrates. Although there was some variation in the behaviour of the various substrates the tendency in all cases was for growth to increase in severity and to occur over a wider range of temperature with rise in humidity up to 100%, and for the growth to demonstrate an optimal temperature range at each humidity. At 60% relative humidity there was no growth on any substrate at any temperature. At 70% relative humidity growth occurred only at 86°F. and the amount of growth was almost negligible. At 80% and 90% relative humidity optimal growth appears to be at 86°F. although it should be mentioned that satisfactory data at 90°F. were not obtained. At 100% relative humidity the maximal growth was in the range of 90-100°F. with growth at 86°F. being only slightly less.

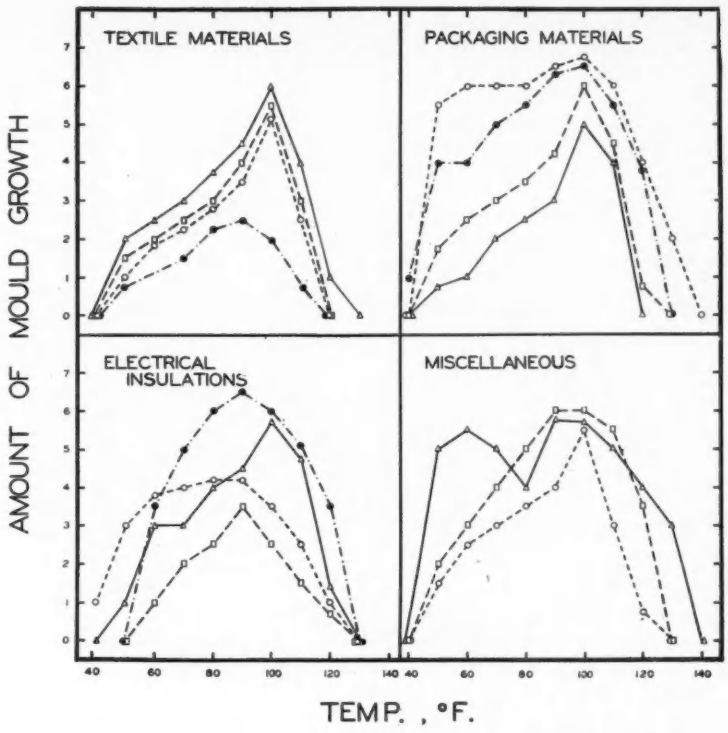


Fig. 3. Mould growth after 3 weeks at various temperatures at near 100% R.H., assessed in arbitrary units from no growth, 0 to very abundant growth, 7.

Symbol	Substrate: Textile materials	Packaging materials	Electrical insulations	Miscellaneous
△	Cotton sheeting, chrome tint	Cellophone M.S.T.	Irvolite plastic spaghetti tubing	Wood, tongue depressor untreated
□	Cotton sheeting, bleached	Kraft paper 30 lbs.	Cotton, dyed and lacquered	Wood, tongue depressor waxed
○	Rayon, viscose	Kraft paper tape, gummed	Rayon — glass	Kendall #5
●	Rayon, cellulose acetate	No-Ox-Id cloth	Cotton, dyed	Paper, filter Whatman 4

TABLE II

Frequency of generic groups at 50-120° F. and approximately 100% relative humidity

Generic group	Specimens showing growth (% of total) 1 wk.	3 wks.
Aspergillus niger	38	58
Aspergillus spp.	10	38
Penicilium spp.	63	70
Paecilomyces spp.	0	14
Alternaria sp.	0	6
Chaetomium sp.	0	2
Stachybotrys	0	0
Memnoniella	0	0
Rhizopus	0	0
Fusarium	0	0

(b) Tropical Chamber Tests

Observations on the extent of growth in the "tropical chamber" are given in Table III. It may be observed that growth was considerably more abundant on the copper oleate than on the copper naphthenate treated samples and that growth occurred more frequently on the waxed than on the unwaxed samples, particularly after weathering. The flora which did occur included species of *Penicillium, Aspergillus* and

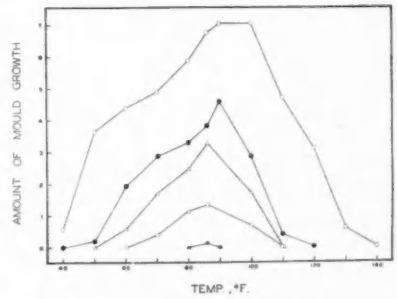


Fig. 4. Amount of mould growth at various temperatures and relative humidities on a total of 15 substrates.

Growth rating: none to very abundant — 0 to 7.

Relative humidity ▲ -70%
□ -80%
△ -90%
● -95%
○-100%

Actinomyces as were reported by Prindle (20) on raw cotton exposed to similar humidity conditions. Apparently the cellulose was not appreciably degraded by these organisms since measurements of breaking strength showed no loss after two months' exposure.

(c) Influence of Free Moisture

The effect of free moisture on the extent of mould growth may be observed in Figs. 5 and 6. Visual observations on the rate of growth are given in Table IV and breaking strength data in Table V. It is apparent that growth occurred much more rapidly on samples which had been subjected to intermittent periods of contact with water of condensation than on samples which were kept in an atmosphere of 100% relative humidity, without contact with free moisture. Eventually the growth on the untreated fabric reached the stage where both samples showed comparable degrees of deterioration such that at the end of eleven weeks the breaking strength losses were in the same order. In the case of the copper naphthenate treated fabric the enhanced susceptibility caused by the presence of free moisture is shown by the greater loss in breaking strength of the moistened sample.

(d) Non-cellulosic Constituents of Unbleached Cotton Duck

Data pertaining to the effect of leaching procedures and the addition of nutrients were based on 3300 measurements of breaking strength. Analysis of variance showed that breaks at the jaws of the machine gave somewhat more erratic and on the whole slightly lower results than normal breaks. This factor is of such great importance in textile testing that mention should be made of similar findings *(7)* recently reported that breaks at the jaws of the machine are significantly lower than normal breaks. The analysis of variance was therefore confined to the average of all normal breaks. The standard deviation of the average of the breaking strength determinations made on a single piece of cloth, calculated from the variance between duplicates was ±11.7 lbs., about 7% of the mean (165.3). The results from individual test pieces were thus of moderate precision, but by virtue of the replication and factorial de-

TABLE III

Mould growth on treated and untreated cotton duck after exposure in "tropical chamber"

Sample	Copper content of fabric %	Amount of growth* after: Exposure in tropical chamber 1 month	Exposure in tropical chamber 2 months	Outdoor weathering 3 months followed by exposure in tropical chamber 1 month	Outdoor weathering 3 months followed by exposure in tropical chamber 2 months
Not waxed					
Untreated	0	+++	+++	0	0
Copper naphthenate	0.10	0	0	0	0
Copper naphthenate	0.31	0	0	0	0
Copper naphthenate	0.98	0	0	0	0
Copper oleate	0.09	+++	+++	0	0
Copper oleate	0.32	+++	+++	0	0
Copper oleate	1.13	+++	+++	0	0
Waxed					
Untreated	0	++	++	++	++
Copper naphthenate	0.09	++	++	+	+
Copper naphthenate	0.21	0	0	+	+
Copper naphthenate	0.62	0	0	0	0
Copper oleate	0.07	++	++	+	+
Copper oleate	0.25	++	++	+	+
Copper oleate	0.76	++	++	+	+

*Abundant growth +++ Moderate growth ++ Slight growth + No growth 0

TABLE IV

The influence of free moisture on the rate of mould growth

Time (days)	Amount of growth*: Untreated fabric, No free moisture	Untreated fabric, Free moisture	Copper naphthenate treated fabric, No free moisture	Copper naphthenate treated fabric, Free moisture
7	0	+	0	0
9	+	++	0	0
16	+	+++	0	0
19	+	+++	0	+
21	++	+++	0	+
23	++	+++	0	++
25	+++	+++	0	+++
27	+++	+++	+	+++
30	+++	+++	+	+++
51	+++	+++	++	+++
79	+++	+++	++	+++

*Abundant growth +++ Moderate growth ++ Slight growth + No growth 0

TABLE V

The influence of free moisture on loss of breaking strength

Sample	Breaking strength (lbs.) 3" between jaws of machine: Original leached	After 11 wks. in bottles	Breaking strength loss (%)
Untreated, no free moisture	115	36	68.7
Untreated, free moisture	115	31	73.0
Copper naphthenate treated, no free moisture	119	83	30.2
Copper naphthenate treated, free moisture	119	43	63.8

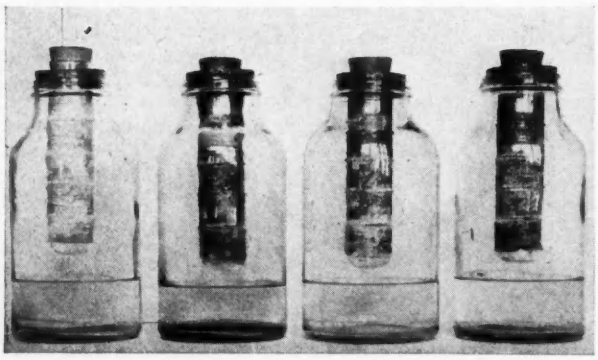


Fig. 5. Influence of free moisture — appearance of samples after 11 weeks.
A. Copper naphthenate treated, no free moisture
B. Copper naphthenate treated, free moisture
C. Untreated, no free moisture
D. Untreated, free moisture

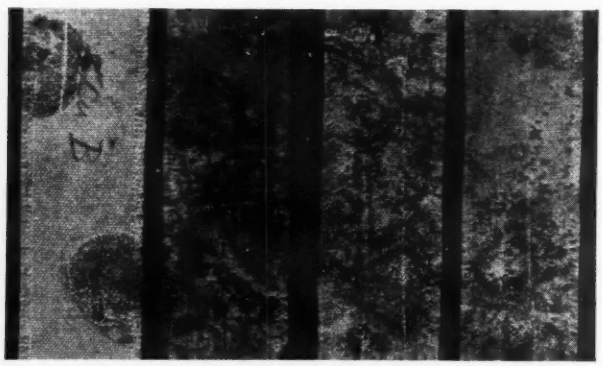


Fig. 6. Influence of free moisture — close-up of samples after 11 weeks.
A. Copper naphthenate treated, no free moisture
B. Copper naphthenate treated, free moisture
C. Untreated, no free moisture
D. Untreated, free moisture

sign of the experiment, statistically significant effects of culture, leaching procedure and added nutrients, as well as various interactions of these factors, were demonstrable.

Considering the cellulose-destroying activity of the various microorganisms, based on the average for all leaching treatments and nutrients, the order of decreasing activity under these conditions was as follows: *Memnoniella,* mixed culture and *Stachybotrys, Chaetomium* and *Metarrhizium.* The actual averages in pounds were 120.7, 161.0, 161.7, 189.2 and 193.9 respectively with a necessary difference at the 5% level of 4.1. Growth in the mixed culture was observed to be largely restricted to *Memnoniella echinata* and *Chaetomium globosum.* Cox and co-workers *(6)* have reported that *Memnoniella echinata* showed an antagonistic effect against *Stachybotrys atra.* This activity was demonstrated well by this experiment since in all of the bottles which received the mixed inoculum only one small colony of *S. atra* was noted. Growth of *Metarrhizium glutinosum* was slightly greater than that of *S. atra* on these samples.

On the whole, considering the averages for all nutrients, the samples which had been leached tended to have higher breaking strengths than did the unleached samples (Table VI). The only case in which the unleached sample gave a higher value than the leached was the samples which had been leached with carbon tetrachloride and inoculated with *Stachybotrys.* Leaching with water produced higher breaking strengths than did leaching with carbon tetrachloride. Leaching with both water and carbon tetrachloride was not significantly different from leaching with water alone excepting a rather curious discrepancy for the mixed culture. The typical behaviour of unleached and water-leached specimens is shown in Fig. 7, where the more pronounced growth of *Chaetomium globosum* on the unleached sample may be observed. The data from this statistically arranged experiment corroborate and extend the findings of Fargher *(8)* who has recently shown that removal of water-soluble constituents by scouring with alkalies increases the resistance of cotton to microbiological attack.

The effect of the addition of nutrients based on the average for all cultures is given in Table VII. It may be noted that there was no significant effect in the case of the unleached or the carbon tetrachloride leached samples. The addition of alfalfa extract and of salts by themselves caused a reduction in breaking strength of samples leached with water and water plus carbon tetrachloride.

Dextrose by itself produced no significant effect, and in combination with alfalfa extract it apparently inhibited the action of the latter. Salts in all combinations with dextrose and alfalfa extract produced significant lowering of breaking strength. The response of all the microorganisms to the addition of nutrients was not the same, the activity being greatest in the case of *Memnoniella* and least with *Stachybotrys* and *Chaetomium.* Data pertaining to *Memnoniella* are given in Table VIII. It is apparent that even with *Memnoniella* the superficial addition of the nutrients to the water-leached samples did not reduce the breaking strength to that of the unleached material without added nutrients. Similar nutrition effects were noted in previous experi-

TABLE VI

The effect of various leaching procedures on breaking strength of cotton duck

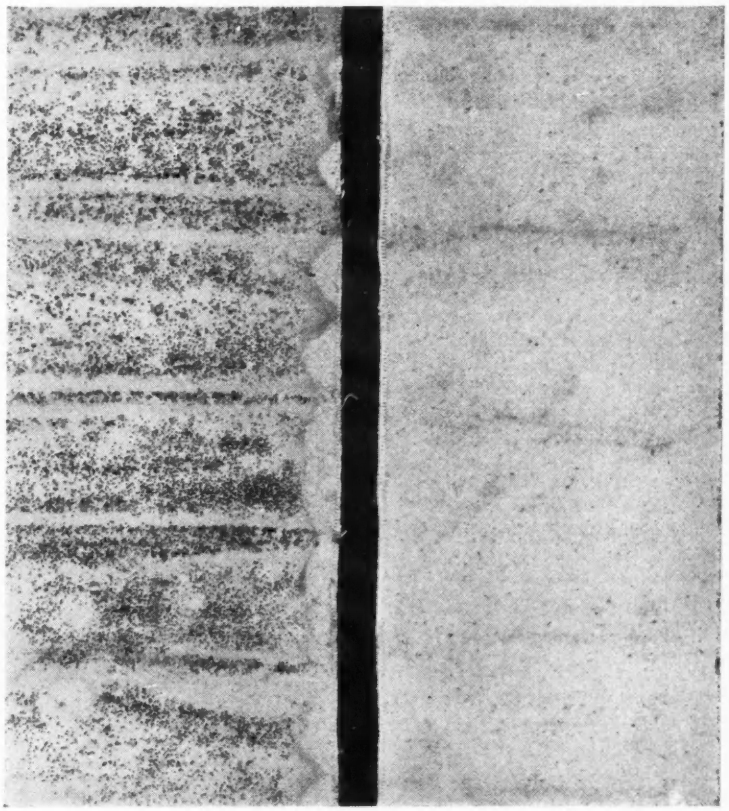
Leaching treatment	*Average breaking strength (lbs.)* after inoculation with:*				
	Memnoniella	*Stachybotrys*	*Chaetomium*	*Metarrhizium*	*Mixed culture*
Nil	90.1	131.0	167.8	177.6	140.1
Carbon tetrachloride	102.8	129.6	180.8	186.0	155.4
Water	143.1	192.0	208.1	205.7	180.9
Water + carbon tetrachloride	147.0	194.1	200.1	206.3	167.4

*Necessary difference (5%) = ±8.2

TABLE VII

The effect of addition of nutrients on breaking strength of cotton duck

Nutrients	*Breaking strength average for all microorganisms (lbs.)**	
	Unleached and leached in carbon tetrachloride	*Leached in water and in water + carbon tetrachloride*
None	143.0	196.1
Salts	144.4	181.6
Dextrose	148.0	192.9
Alfalfa	149.4	182.6
Salts + dextrose	145.4	174.9
Salts + alfalfa	144.1	175.0
Dextrose + alfalfa	148.1	190.6
Salts + dextrose + alfalfa	146.6	182.0
*Necessary difference (5%) = ±7.4		
*Breaking strength average** for all nutrients including or not including salts:*		
No salts	147.1	190.6
Salts	145.1	178.4
**Necessary difference (5%) = ±3.7		



A B

Fig. 7. Growth of Chaetomium globosum on unleached fabric (A) and fabric which had been leached in water (B).

TABLE VIII

The effect of the addition of nutrients on the breaking strength of cotton duck inoculated with Memnoniella

Nutrients	Breaking strength average (lbs.)* Unleached	Leached in water
None	83.5	167.5
Salts	85.5	135.0
Dextrose	96.0	189.5
Alfalfa	94.0	137.5
Salts + dextrose	92.5	140.0
Salts + alfalfa	81.5	114.5
Dextrose + alfalfa	95.5	142.0
Salts + dextrose + alfalfa	92.0	120.0

*Necessary difference (5%) = ±23.1

ments in the "tropical chamber" *(16)* but in these earlier tests pre-wetting of the fabric even with distilled water caused greater degradation than no wetting. This latter effect evidently was not, as originally stated, due to leaching but rather to increased moisture retention in the high humidity atmosphere by the fabric strips which were previously soaked and not thoroughly dried.

Discussion of Results

For the storage of materials which are similar in type to the ones studied it is probable that relative humidities of 60% or lower would be safe. With higher relative humidity, the temperature must be considered. A relative humidity of 70% would probably be safe for most substances, particularly if the temperature were not at 86°F. The critical temperatures for relative humidities of 80, 90 and 95% appear to be 60, 50 and 40°F. in the lower range and 100, 110 and 120°F. in the upper range respectively. With 100% R.H. the temperature would have to be below 40°F., which was the lowest temperature studied, or at 140°F. It should be borne in mind that in cases bordering on the minimal and maximal temperature limits the duration of storage might become significant and that the above data were based on a one month period. The data also presuppose the absence of free moisture on the substrate, since it seems possible that the effect of free moisture in accelerating the growth on cotton fabric might also be evidenced on other substances. It is also possible that in the tropics the mould growth might be influenced by condensation induced by the climatic conditions in the daytime of high temperatures with relatively low humidity and at night of lower temperatures with higher humidity. A similar scheme allowing for condensation to take place on the articles exposed in a "tropical chamber" has recently been described *(5)*. In connection with the condensation on the samples of untreated and copper naphthenate treated duck, it should be mentioned that a recent study *(4)* showed that leaching with water produces changes in copper naphthenate which make the compound more susceptible to rotting as judged by the soil burial test. It is possible that the same action might have taken place in this experiment. However, in this experiment, the condensation of water on the untreated fabric caused an acceleration of growth whereas when the water-soluble constituents were removed by leaching in running water the extent of growth was diminished. It is therefore apparent that condensation did not have a severe leaching action and that the behaviour of the copper naphthenate treated sample was probably due at least in part to the persence of free moisture, rather than to changes in the copper naphthenate brought about by leaching.

In the case of unbleached cotton fabric it is apparent that prior to storage a treatment to remove certain of the constituents of the unbleached fabric is advantageous. This treatment may take the form of an alkali scour as recommended by Fargher *(8)* or more simply a leaching in water.

It is interesting to note the comparative behaviour of copper naphthenate and copper oleate in the tropical chamber. In these experiments copper oleate both unwaxed and waxed supported the surface growth of microorganisms whereas copper naphthenat unwaxed did not support growth even in concentration of 0.1% copper, and waxed only at a concentration of 0.09% copper. The failure of the copper oleate treated samples to prevent the development of surface-growing organisms was also observed in these laboratories when a set of these unwaxed samples was hung in a room which was being used for soil burial tests and which was maintained at 86°F., 75-80% relative humidity. The corresponding set of fabrics containing copper naphthenate showed no evidence of growth. Other published data report that copper oleate supports organisms of the surface growing type but resists the cellulose-destroyers *(13)*, and also that in soil burial tests copper oleate was inferior to copper naphthenate in concentrations up to 0.4% copper *(17)*. In soil burial tests on these samples the copper oleate was inferior to copper naphthenate in concentration of 0.1% copper but similar in behavior in higher concentrations *(2)*.

Weathering had a beneficial effect in reducing the growth of microorganisms which could be attributed at least in part to the leaching action of rain. The effect is emphasized in the case of the copper treated samples since weathering caused a marked reduction in the copper content of the samples, and it might be expected that the mould resistance would be correspondingly decreased. It should be kept in mind that although the mould resistance of the samples was increased by weathering the actual strength of the fabric was substantially reduced by the effects of weathering.

In this work it was not intended to study the preservation of cotton in storage by the use of various mildew antiseptics. Discussions of such compounds have been given elsewhere *(8, 10, 18)*.

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Acknowledgments

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—♦ ♦—

• Change of Monsanto Officers

Daniel S. Dinsmoor, vice-president of Monsanto Chemical Company and general manager of the company's Merrimac Division with headquarters at Everett, Mass., has submitted his resignation to enter the chemical consulting profession, William M. Rand, president, has announced.

Succeeding Mr. Dinsmoor as general manager of the division will be Josiah B. Rutter, now director of the General Engineering Department. Mr. Rutter, in turn, will be succeeded by Fred G. Gronemeyer, who is at present assistant director of the General Engineering Department.

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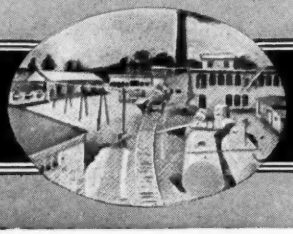

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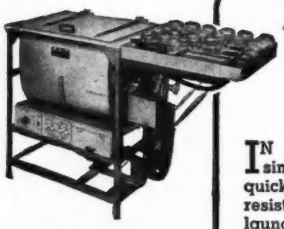

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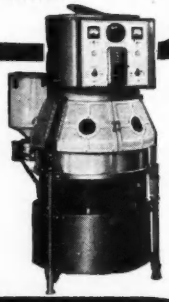

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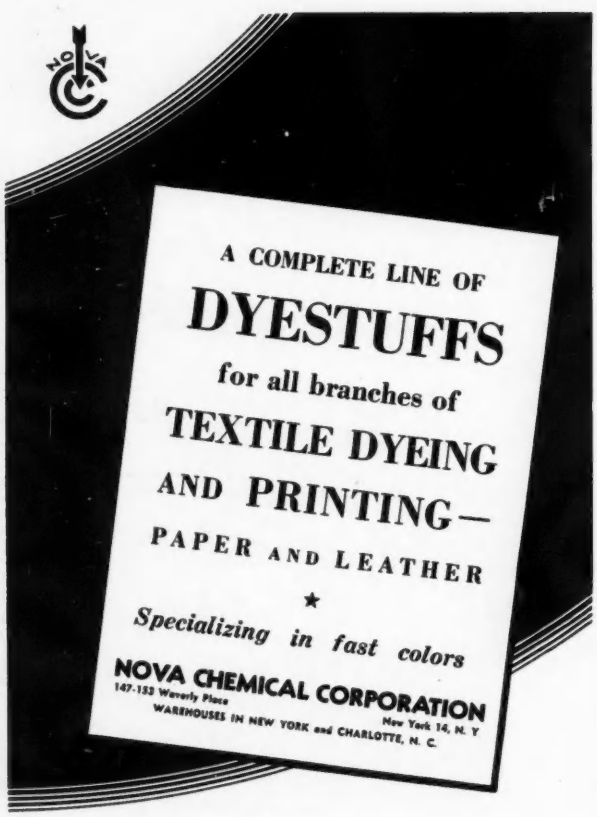

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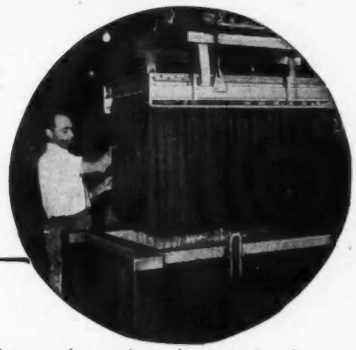

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Procter & Gamble .....
Proctor & Schwartz, Inc. .....

Refined Products Corp. XV
Richmond Oil, Soap & Chemical Co., Inc. ..... XIV, XVI
Riggs & Lombard, Inc. .....
Rohm & Haas Company .....
Royce Chemical Co. ..... Back Cover
Rumford Chemical Works .....

Sandoz Chemical Works XIII
Scholler Bros., Inc. .....
Smith, Drum & Co. .....
Socony-Vacuum Oil Co., Inc. .....
Solvay Sales Corp. VIII
Sonneborn Sons, Inc., L. .....
Standard Brands, Inc. .....
Standard Chemical Products, Inc. .....
Standard Oil Co. of N. J. VII
Stein Hall & Co., Inc. .....

Tennessee Eastman Corp. .....
Titan Chemical Products, Inc. .....

Union Carbide & Carbon Corp. .....
United Chemical Prod. Corp. XIX

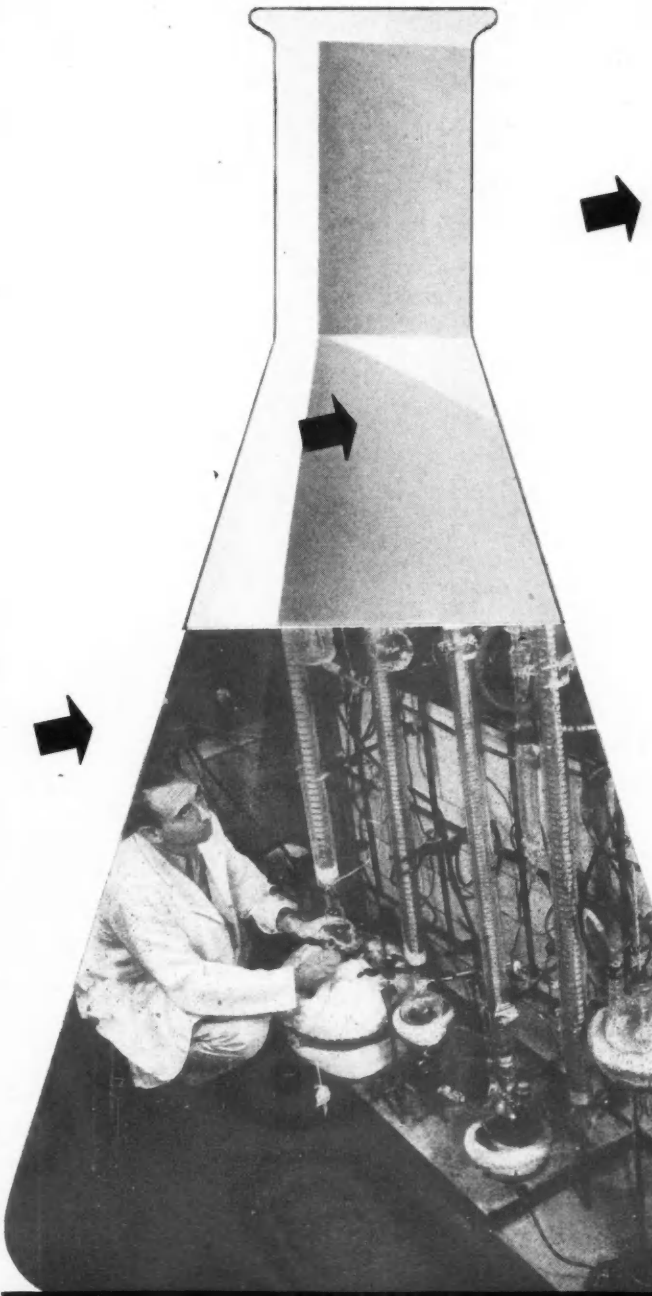
Vanderbilt Co., R. T. .....
Van Vlaanderen Machine Co. .....
Virginia Smelting Co. .....

Wallerstein Co., Inc. .....
Warwick Chemical Co. .....
Watson-Park Company XIV
Wolf & Co., Jacques .....

Young Aniline Works .....
Young Co., J. S. .....

Zinsser & Co., Inc. .....

RS
Third Cover
VI
Second Cover
XIX
XX
XII
XXII
XIV
XVIII
X
III
Front Cover
V
IX
XIX
XIX
XVII
XXI
XVI
IV
XV
XIV, XVI
Back Cover
XIII
VIII
VII
XIX
XIV
e 30, 1947



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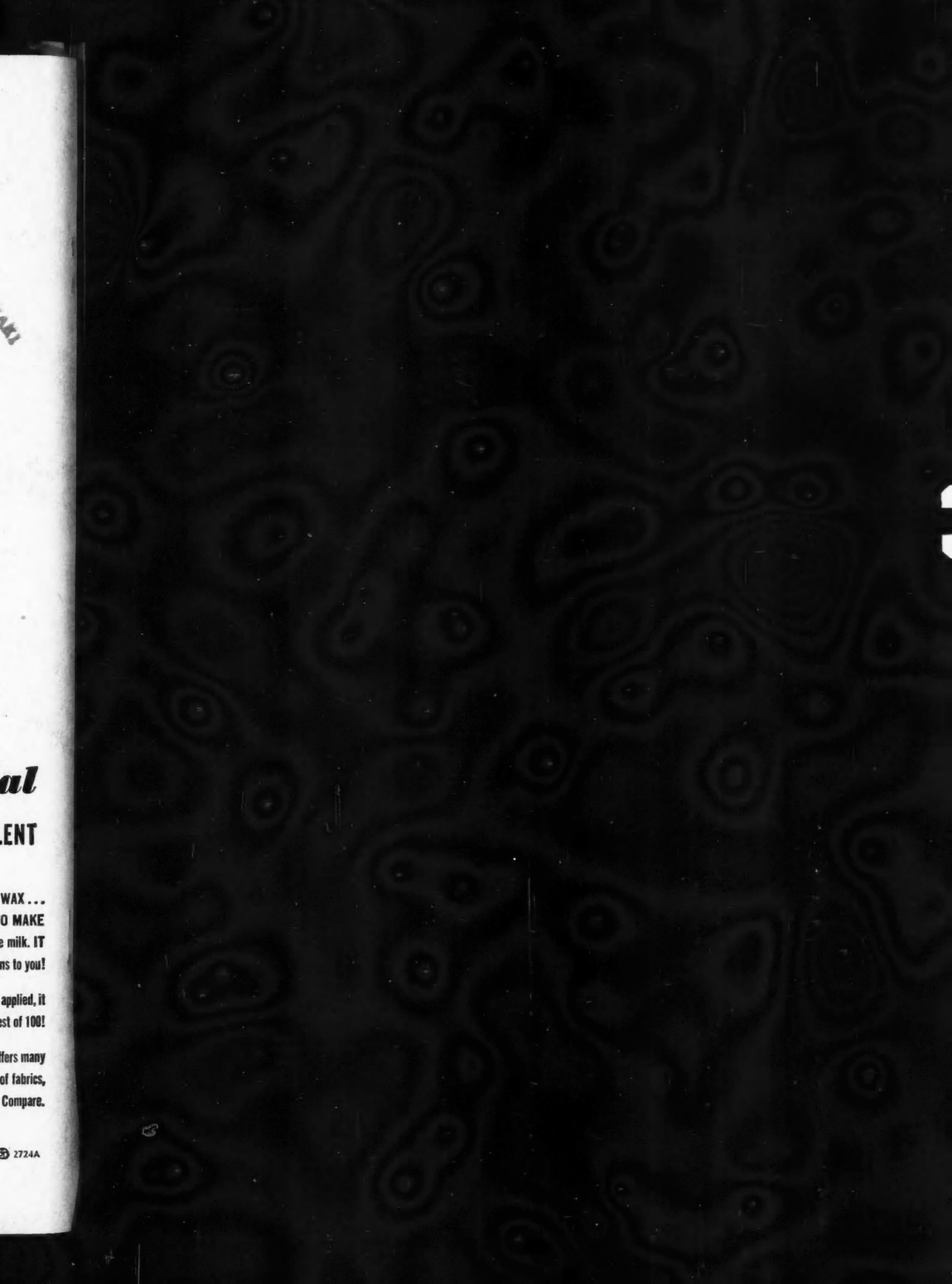
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